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The eight-hour law is causing trouble in the award of the last $1,500,000 gun contract for the army. Bids for the forgings of these guns have been received by the Ordnance Bureau from the Bethlehem Iron Works and the Midvale Steel Works. The first company bids 28 cts. per pound for all forgings, with an added ¼ ct. in case the eight-hour law applies to this contract. The latter company bids 28 cts. per lb. for the 8-in. forgings, and 29 cts. for the 10-in. and 12-in. forgings, but does not bid contingent to the labor law, which was passed since the bids were called for. The contracts may have to be again advertised.

English railway accidents in 1891 are detailed in the general report to the Board of Trade, just published. It shows that during the year 1,168 persons were killed in the working of railways in the United Kingdom, and 5,060 were injured. Of passengers 103 were killed, and 1,612 injured. In addition to these, 79 persons were killed and 6,440 injured from accidents occurring on the railway premises, but not connected with the movement of trains. The proportion of passengers killed was one in 8,208,385; and one in 524,481 was injured. In 1890, this proportion was one in 6,030,034 killed, and one in 600,840 injured. Other statistics, concerninf the passenge accidents were given in our issue of Sept. 1. The classes of accidents to railway servants may be set forth as follows:

	Killed.	Injured.
Coupling and uncoupling	24	297
Shunting	136	1,404
Caught between vehicles	19	64
Falling between trains and platforms	17	75
Working on permanent way	115	108
Walking on line on duty	146	259
At level crossings (strangers)	66	31
Trespassers on railway	306	161

A slightly chipped valve on a Frost carbureter pipe connection recently permitted air to flow from the brake pipe too rapidly, and thus released brakes within 10 seconds after their application on a train of the East Tennessee, Virginia & Georgia R. R. The mechanical officers of the road, being unfamiliar with the system, were unable to locate the trouble until after a long investigation. It has been claimed that the consumption of air from the train brake at times tends to apply brakes, but this is the first instance which has come to our knowledge of an opposite effect.

By an order of the Interstate Commerce Commission, all railways required to report to it at all are required to file their annual reports with the Interstate Commerce Commission on or before Sept. 15 of each year, the report being for the year ending June 30.

The centennial of the inauguration of the New York canal system is at hand, and the growth of the traffic in that time is interesting. In the 20 years of 1837-56 the total traffic was 50,326,487 tons, with an estimated value of $2,586,465,277. During the 20 years ending with 1891, the total tonnage, however, was 109,844,759 tons, of an estimated value of $3,315,599,201, or more than double the tonnage of the first named period. In 1891 these canals carried to New York one-third of all the grain delivered at that port. And if the 7 months of navigation in the 8 years ending with 1891 are alone considered, it is seen that considerably more than half the total receipts came by the canals. As to the influence of the canals on freight rates, it is pointed out that while the rail rates from Buffalo to New York were 7 4-5 cts. per bushel when the canals opened in May, 1891, they at once fell to 2⅝ to 3 cts. per bushel to meet canal rates; but they doubled again the day after the canals were closed. The State Superintendent of Public Works estimates that the saving to the consumer by reduced rates, from May 1 to Dec 1, on grain alone, amounted to over $4,000,000.

The new jetties channel for Charleston, S. C., harbor showed on Aug. 26 a minimum depth of 14 ft. 6 ins. over a shoal about 200 ft. wide, according to the soundings reported by the U. S. revenue steamer "Morrill." This is said to be a gain of 3 ft. in two months. The ultimate purpose of these jetties is to obtain a 21-ft. channel-way to the sea.

A head collision on the Cambria & Clearfield branch of the Pennsylvania R. R., on Sept. 8, and a rear collision on the Fitchburg on Sept. 10, were the two railway accidents of the week of greatest fatality. In the first 9 were killed and 6 were injured, and in the Fitchburg disaster 8 were killed and 25 or 30 injured. As the latter occurred near a large city and the fatalities were among passengers, its details have been reported far and wide. Those killed in the other accident were the engineer and fireman of one of the trains and a number of laborers employed on a work train, and little has been said of the accident in the papers. The causes of these collisions are the familiar ones. In the Pennsylvania disaster the engineer of a work train disobeyed orders and ran ahead of the siding where he should have stopped, colliding head on with the regular passenger train. On the Fitchburg a crowded local passenger train standing at a station was run into by a freight train. The locomotive telescoped the rear passenger car so far that its pilot was underneath the front trucks. A Burton stock car and a refrigerator car just behind the engine were not injured, but a dozen or more ordinary cars following them were badly smashed. There were 30 cars in the train. The accident occurred about 10:45 p. m., and a dense fog prevailed at the time. The rear brakeman of the passenger train claims to have gone back with his lantern, but does not seem to have used torpedoes, although the train was supplied with both torpedoes and fusees. The freight engineer claimed that the station signal showed a clear track and that he did not see the brakeman's lantern. His train had only hand brakes and though he reversed his engine and whistled for brakes as soon as he saw the light on the rear car, the momentum was little reduced when the shock came. The investigation of the State Railroad Commission ought to develop some interesting facts concerning the train rules on the Fitchburg and the extent to which they are observed, and also concerning its use of air brakes.

That a dim oil lantern in the hands of a brakeman as the sole danger signal to protect the lives of a train load of passengers is a very crude system of train operation is a fact which railway managers and owners will eventually learn. Here is another of many instances which show it. On the Central R. R. of New Jersey on Sept. 11, a freight train ran into a light engine, killing the engineer. The fireman of the light engine went back to signal the freight, but his lantern went out just when it was most needed.

As an instance of the frequency of collisions resulting from this frightfully inadequate "rear brakeman" system of protecting trains, it is stated that the engineer of the freight train had been in another rear collision only two days before. He "was not signaled in time" and ran into a freight train.

An accident from an unusual cause on the Pennsylvania R. R., near New Brunswick, N. J., on Sept. 13, caused the death of two men. A hanging brake chain on one of the cars of a fast express caught on the point of a facing switch and jerked it open far enough to turn the rear truck of the next to the last car onto the siding. The last car, however, followed the main line and the coupling held up the end of the car in front which had lost its truck. The loose truck ran into a freight train on the siding, killing a trackwalker who stood in its way, and a piece of flying iron killed a freight brakeman.

Some very interesting tests of a new method of measuring the velocity of projectiles by sound, are recorded in the "Engineer." Its great accuracy, which makes it as practically accurate as any other, may be shown by the following comparative measurements of initial velocities in feet per second, by the sound method, and by the usual screen method:

	1	2	3	4	5
By sound	529.7	447.6	604.0	601.0	440.1
By screen	528.2	447.1	602.2	601.8	441.1
	6	7	8	9	
By sound	439.5	617.5		616.7	616.4
By screen	442.7	616.6-621.6		618.8	616.5

The principle of the method is that a wave which accompanies a projectile moving at high velocity can cause a signal to be given at the moment of passing a given point near to its trajectory. The interval of time which elapses between passing any two points can be thus measured by the aid of current breakers and chronographs; and by having three or more such pairs of points on the trajectory (all of which are on a single circuit) the velocity at almost any point in the trajectory can be computed.

Work on the Chicago drainage canal was formally inaugurated on Sept. 3, with speeches by Mr. Frank Wenter, President of the Sanitary District of Chicago, and by Mr. Lyman E. Cooley, the Engineer, and member of the board. This canal was fully described in our issue of June 2, 1892. Actual construction is now to follow about seven years' hard work by engineers, and more or less bitter, personal and political discussion.

The New York Rapid Transit Commission is nearly ready to announce the specifications upon which bids will be invited for the franchise of the proposed underground system. As near as can be learned, the Commission will not specify the method of construction, leaving this to the judgment of the purchaser. The only provision as to motors will be that there must be no combustion in the tunnel; electricity will be preferred as a motor. Gradients will not be fixed by exact regulation. The requirements will be sound construction; speed and non-combustion in motors; no damage to buildings along the route; fixed station points, and general rules for completion and operation. Mr. John Bogart, the engineer for the Commission, admits that actual work is necessary to locate various obstacles in the way, as even the pipes can not be definitely located from official city records. The purpose of the Commission will be to give the widest liberty of action, in plans and details, to the purchaser, and to be generous in policy so long as the essential conditions imposed by law are met.

The Multiple Speed & Traction Co. has been granted permission to install its moving sidewalk, described and illustrated in our issue of Feb. 27 upon the long pier at Jackson Park. The company is to pay the Exposition $25,000 and one-third of its gross receipts. The fare is to be 5 cts. The Exposition managers have also granted a concession for a spiral tower to be erected at the western end of the Midway Plaisance, the company erecting it to pay $10,000 and one-third of its gross receipts.

A school of instruction for car-heating has been inaugurated by the Consolidated Car Heating Co., at its new factory in Albany, N. Y. The employees in all departments attend and specialists explain to them the theory of hot water and steam heating in all its branches, accompanied by practical illustrations. Discussion follows, possible errors in experiment are pointed out and questions answered. The first meeting was a highly successful one in its attendance, extending over two days.

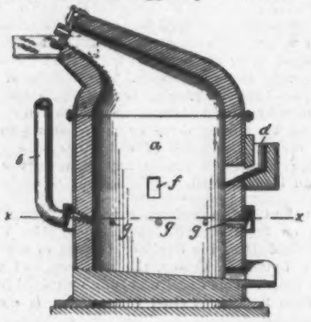
The War College at Newport, R. I., was formally opened on Sept. 6. This college, for which Congress appropriated $100,000 for the building several years ago, is intended for the instruction of naval officers in the theory and practice of modern naval warfare.

A broad-tire ordinance is now before Select and Common Councils, of Philadelphia. The ordinance is intended to regulate the width of tires running over asphalt pavements, and provides that: For a wagon with its load weighing 4,000 lbs., the tire shall be 3 ins. wide; 5,000 lbs., 4 ins. wide; 6,000 lbs., 5 ins. wide, and 7,000 lbs., 6 ins. wide. It also provides for a fine of $25 on each vehicle violating the ordinance.

Three more guns for the U. S. S. "Monterey" have been shipped by rail from Washington to San Francisco. One is a 12-in. mate to one already delivered, weighing 101,300 lbs., and the others are two 10-in., weighing 61,900 lbs. each. The 12-in. gun was carried on the special car already used and described in Eng. News of Jan. 30, 1892. The two 10-in. were shipped on ordinary platform cars strengthened for the special purpose.

IMPORTANT INNOVATIONS IN OPEN HEARTH AND BESSEMER PRACTICE.

The Bessemer converter and the Siemens-Martin or open hearth furnace as now used have suffered little change from the form developed in the early days of steel manufacture. In all other parts of the plant a modern steel-works differs greatly from its predecessors of twenty years ago, and recent and important inventions are seen everywhere. Of course methods of working of the furnaces themselves have been greatly changed and their size has been much increased; but now, as twenty years ago, the Bessemer converter is an egg-shaped vessel with the



A Surface-Blowing Bessemer Converter.

x-x, Metal line; *g, g, g*, Tuyere openings; *f*, Slag hole; *d*, Charging hole; *b*, Blast main.

blast entering its bottom, and the open hearth furnace is the same fixed structure which was in use then.

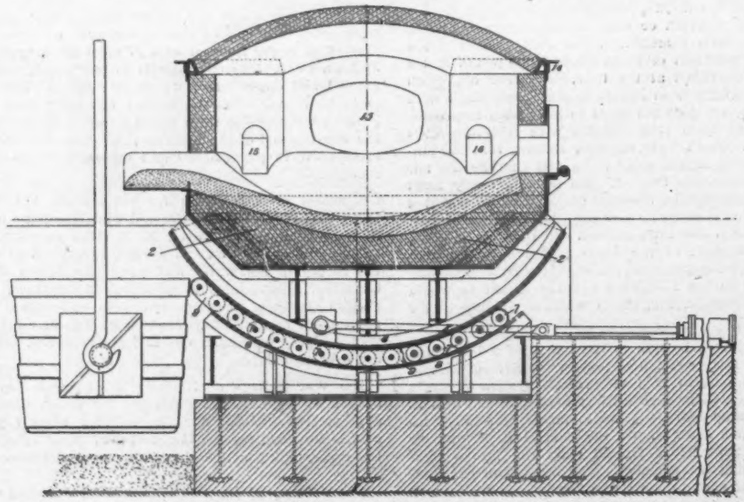
We illustrate herewith some important proposed changes in the open hearth furnace and the Bessemer converter, which are of much interest from their novelty and boldness as well as from their origin, their inventors being all well known in metallurgical circles, and in positions where they can readily put their ideas to the test of practical service.

The proposed change in Bessemer practice is covered by a patent (No. 481,881) just issued to Mr. Jas. P. Witherow, M. Am. Soc. M. E., whose work in iron and steel works construction is familiar to many of our readers. The inventor's idea is to locate the tuyere mouths near the surface of the metal in the converter instead of at or near the bottom, as in present practice. The reason for this change is given as follows in Mr. Witherow's specifications:

It has been customary in the treatment of molten metal by what is known as the "Bessemer process" to subject a large quantity of metal to the action of a high-pressure blast of air entering the converter through tuyeres, placed at or near the bottom, for the purpose of blowing through the entire charge. The weight of the metal upon the mouths of the tuyeres is so great that it is necessary to have a strong blast-pressure to keep the tuyeres clear. In addition to this the tendency of the Bessemer practice is to increase the pressure of the blast, on account of its more rapid action on the crude metal. As the blast cannot be stopped until the converter is tipped, or the metal falls below the nozzles of the tuyeres, it follows that the portion of the charge which is last to leave the converter in tapping is subjected to the action of the blast for a longer period than the first portion of the metal. The result is that the ingots vary in character, and are not homogeneous in structure. Various expedients have been adopted to obviate this evil. It was for this purpose that the tipping converter was devised. This, however, does not entirely obviate the trouble because the tuyeres do not all leave the metal at the same time, while the converter is turning over. Another expedient is found in the Clapp & Griffiths stoppers, by means of which the blast may be shut off at pleasure without danger to the tuyeres.

It is desirable in the manufacture of ingot iron and steel to treat the metal at a low pressure, or to so apply the blast, that it operates upon but a portion of the metal at a time. To accomplish this, and at the same time to avoid the necessity of using stoppers, without, to any considerable extent, destroying the uniformity of the product, I have devised my present improvement, in practicing which the tuyeres are arranged either horizontally or with a downward projection at or near the surface of the metal in the converter, so as to blow on or near the surface of the charge. When thus arranged, there being but a small portion of metal above the nozzles of the tuyeres at any time, only a very mild or low-pressure blast is necessary to keep the mouths of the tuyeres clear and but a small portion of the metal is treated at a time. The effect of the blast, however, is to cause an upward circulation of the molten metal, which will bring all portions of the entire charge successively under the oxidizing influence of the blast, so that it is thoroughly decarbonized and purified during the operation. When the charge is tapped off, the tuyeres being at or near the surface, the molten metal soon falls below them, so that but little harm is done by keeping on the mild blast which is used, and there is no want of uniformity in the product.

The tuyeres being arranged at or near the metal line, and below the slag-hole f, the blast acts only on the upper portion of the charge; but it causes or creates an upward circulation of the metal, which brings every portion of the charge successively under its oxidizing influence; portions of the metal being in and by such circulation successively agitated and atomized, or broken up into small particles. The slag being formed at the surface of the bath is more perfectly separated therefrom than where the tuyeres are arranged below, and more easily removed after separation by skimming off or by flushing it through the slag-hole when it boils up during the operation. It will be evident to those skilled in the art that this operation is not necessarily conducted in the particular construction of fixed converter described, and I propose to apply the oxidizing process set forth to any form of converter or converting vessel known in the art. For example, the air-blast, when applied in the manner above described to the molten metal while being held in a ladle or receiving reservoir, will keep the metal from chilling, and partially purify the charge, or, if the blast and agitation be continued for a sufficient time, the crude metal may be completely refined in the ladle or receiving chamber, suitable means being provided for the removal of the slag. The upward circulation or agitation of the charge of metal, in the manner described, whereby the lower parts of the charge rise and pass in procession in front of the tuyeres, and then sink to the bottom to give place to other rising portions, may be assisted by mechanical means. An agitator may be inserted in the bath, or the metal may be thus treated in a revolving hearth, mechanical puddles or oscillating converter.



A TIPPING OPEN-HEARTH FURNACE.

The change in open hearth practice shown in the accompanying cut is even more radical than that in Bessemer practice just described. The inventors propose to build an open hearth furnace on rockers, so that it can be tipped to pour off the slag and later the purified metal instead of tapping it off in the ordinary manner. That this is not a chimerical scheme is evident from the fact that the names attached to the patent are those of Henry Aiken, Frederick W. Wood and Harry H. Campbell. The first is a well-known inventor and mechanical engineer of Pittsburg. Mr. Wood is Superintendent of the Maryland Steel Co.'s works at Sparrow's Point, and Mr. Campbell is a member of the staff of the Pennsylvania Steel Co. We quote as follows from the inventors' specification;

Our invention consists in a furnace of improved construction set upon rockers and adapted to be tipped for the purpose of pouring the slag and metal. It is especially applicable to open-hearth furnaces, and its use results in a great saving of labor and time as compared with furnaces ordinarily used. The furnace is simple in construction, is strong, is operated with safety, and is efficient in performing the work for which it is designed. Its advantages as compared with prior constructions will be appreciated by those skilled in the art.

In the drawings, 2 represents the hearth of an open-hearth furnace, which is built upon a metal framework of plates and curved parallel rocker-bars, which are secured to the plates by vertical webs and bracing-plates. When the furnace is in position for use, the rocker-bars rest upon a series of movable anti-friction rollers 7, which are set between the lateral confining-plates 9 of curved rails 8, constituting a supporting-cradle, the rails being supported on a foundation as shown. These rollers are not journaled in stationary bearings, but are capable of traveling laterally somewhat when the furnace is tipped, as hereinafter described. The hearth 2 is provided with a suitable lining, and upon the hearth are built the furnace walls, surmounted by a roof, the walls being preferably incased in a metallic jacket and the roof being provided with a marginal inclosing frame 14, which is secured to the walls. On opposite sides of the furnace are ports 15 for the admission and exit of the heating-gases and charging-doors 16. At the end of the furnace, toward which it is oscillatory, is an opening provided with a spout, which is suitably lined to resist the action of the molten metal and slag.

The purpose of setting the furnace on rockers in the manner above described is to permit it to be oscillated with a limited range of movement, and the curvature of the rockers is such that the center of oscillation shall be about the middle of the opposite ports 15. The furnace is so set, that said ports shall be directly opposite and adjacent to the ends of flues which lead from and to the generators from which gas and air are admitted and to which the products of combustion are passed with a reversing action in the manner common in operating open-hearth furnaces. By thus having the center of oscillation opposite these flues, the connection of the furnace with the regenerators is preserved in every position. The materials of the furnace are so disposed, as shown in the drawings, that the center of gravity shall be below the center of oscillation. This is an important factor of safety, and the result is that if the tipping mechanism of the furnace should break or get out of order the furnace will not tend to upset, but will of itself assume or remain in a stable position.

In order to tip the furnace, we prefer to employ the mechanism shown in the drawing. This consists of a hydraulic cylinder whose plunger is provided with a cross-head, connected by a link or links with the rocker-frame of the furnace, so that by moving said plunger longitudinally the furnace may be tipped on its rockers within a limited arc, and thus caused to discharge the molten slag or metal from the hearth.

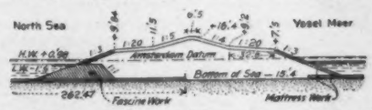
Further on in their specification the inventors allude to the adaptation of this furnace to the basic process. It is not unlikely that the large quantities of slag produced in the basic process and whose removal in the ordinary furnace is quite a task, was what originally suggested to the inventors the advantages of a tipping furnace.

RECLAMATION OF THE ZUYDER ZEE, HOLLAND.

For some years past, we may almost say for some centuries past, or ever since the Zuyder Zee was formed by terrible storms in 1219 and 1282, a project has been under consideration to drain that great inland bay, to reclaim the land and make a

new area available for cultivation, and work is now in progress on the dam to shut out the North Sea. When the sea was first formed as many as 100,000 people and 72 villages and towns were destroyed, so that an incidental effect of these reclamation works will be the recovery of many interesting and pathetic relics. The situation of the lake and of the dam are shown on the accompanying map. The foundation of the dam already extends from near Ewijcksluis, in North Holland, running from the north point of North Holland across to the island of Wieringen, and thence straight across the Zee to Makkum, a point on the opposite coast of Friesland, a distance of only 18 miles. It has been found that as the work advances the sea itself assists by depositing enormous quantities of sand and silt every tide on both the outside and inside of the dam which is being gradually raised along its whole length simultaneously. Subsequently a canal is to be constructed to connect Harlingen on the north coast of Friesland with the remaining part of the Zee, a small area in the center which will be called the Yssel Meer, and left as a lake, and with the North Sea. When the project of draining the Zee took shape 40 years ago, the first idea was to join by dams the great islands of the Texel, Vlieland, Terschelling, and Ameland to each other and to the main land at each end. The total length of dams required for this would have been only the same as that from Wieringen to the Friesland coast, and it

Map Showing Land to be Reclaimed From the Zuyder Zee, Holland.



Cross Section of Proposed Dam Across Zuyder Zee, Holland.

would have reclaimed from the sea about half as much again as the present plan; but the tide going in and out through the openings four times daily, with tremendous strength, and in enormous volume, could not be coped with. It had hollowed out deep channels between the islands, from which it was considered vain to attempt to dislodge it. When the tides have been excluded altogether subsidiary dams will be built and the water pumped out into the sea. The amount of land shut off by the dams as thus finally completed may be as much as 1,000,000 acres, of which fully 750,000 acres will consist of rich clayey soil, indicated by hatching on the accompanying map, as recent borings have demonstrated. The remainder, the Yssel Meer, connected with Amsterdam and the mouth of the Yssel by navigable canals, will on account of its future elevation above the level of the North Sea, serve as a fresh water basin for the adjoining territories.

The great dam, the cross-section of which is shown in accompanying illustration, for which we are indebted to the "Centralblatt der Bauverwaltung," is to be constructed in an average depth of 13 ft. to 19.7 ft. of water. To secure its foundation against undermining by the tides, mattress work is employed. On the outer side a part of the dam is to be constructed of fascines to a height about level with low water. The lining of the slopes also consists of fascine mattresses and stones. The top of the dam is to be 16.5 ft. above low tide; its crown being 6.5 wide. The berm to the lake side is to carry the tracks of a railway line from North Holland to the province of Friesland. The material used in the construction of the dam is earth, obtained principally from excavations for the drainage and navigation canal across the island of Wieringen, the location of which is shown on accompanying map. The 24 flood-gates to be constructed will have a width of 41 ft. each and are arranged in six groups, the 24 openings aggregating 984 ft. in width. At the side of those two locks of 26.2 ft. and 45.9 ft. width respectively will be provided for navigation. The canal itself is to be 3,280 ft. wide with a depth of 14.4 ft. within the locks, narrowing subsequently to a width of 1,640 ft. It is estimated that the value of the reclaimed land will be vastly in excess of the estimated cost of the work which is stated to be about $95,000,000. The amount of redeemable land will be as stated above, 750,000 acres at least, and its value is reckoned at $400 per acre. The value of the new province will thus be some $300,000,000, of which sum more than two-thirds will be net profit on the enterprise. These are said to be conservative estimates, and not likely to be exceeded. The work, therefore, promises to yield enormous immediate profits, while its ultimate value to the kingdom is incalculable. It will add more than 10% to the area of Holland, with all that that implies in increase of population, wealth and industry. It will also materially modify the climate of the provinces of Utrecht, Gilderland and Oevryssel, and will make great changes in their commercial and industrial conditions.

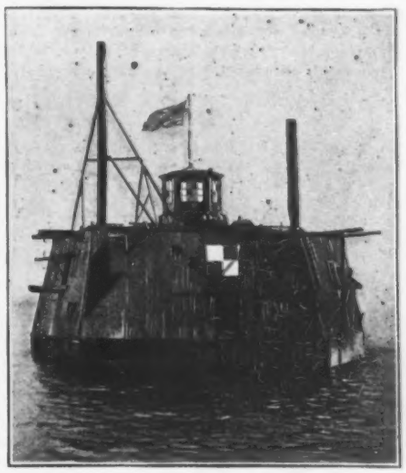
CHICAGO'S NEW FOUR-MILE LAKE TUNNEL AND ITS APPENDAGES.

By Bernhard Feind, M. Am. Soc. C. E.

(Continued from p. 237.)

Intermediate Cribs and Shafts.

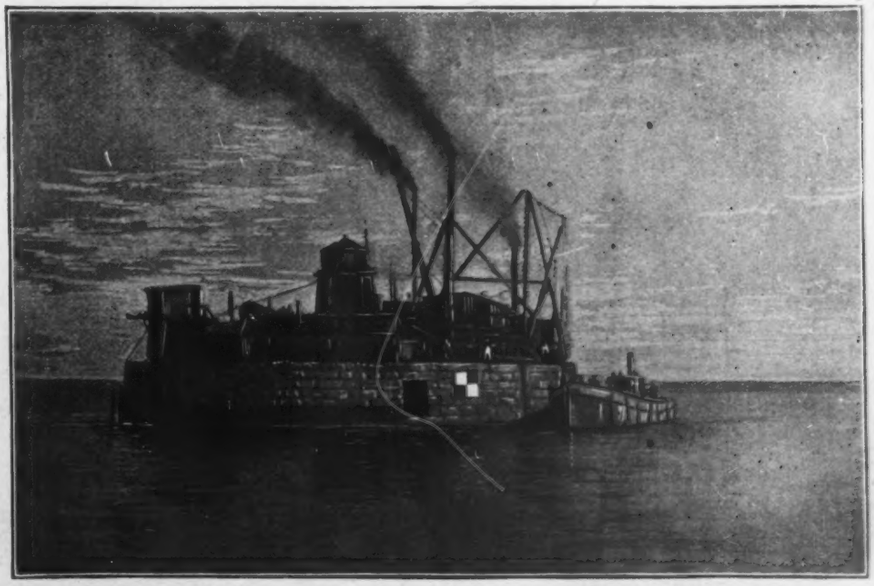
The breakwater crib and shaft were not contemplated in the original contract, and were inserted into the system subsequently in order to attain a lower level and more favorable soil. The crib is a structure with a timber shell and rip-rap filling; the upper part of the shaft is of cast iron and the lower part is of brick. More details were given in our issues of July 5, 1890, and Sept. 8, 1892.



The 2 1-2 Mile Crib, Chicago Water-Works.

specifications left the mode of construction with the contractor, who first chose to build two concentric steel cylinders, of 70 and 30 ft. diameter, respectively, connected by radial braces and ties. They had no bottom but were to be floated out and sunk in place while suspended by chains from scows. The annular space between them was to be filled with sand. After completion the double shell was to be lifted out bodily, and the sand filling was to be dredged away. The compensation awarded in the contract for the intermediate structure included its removal after completion of the lake tunnel.

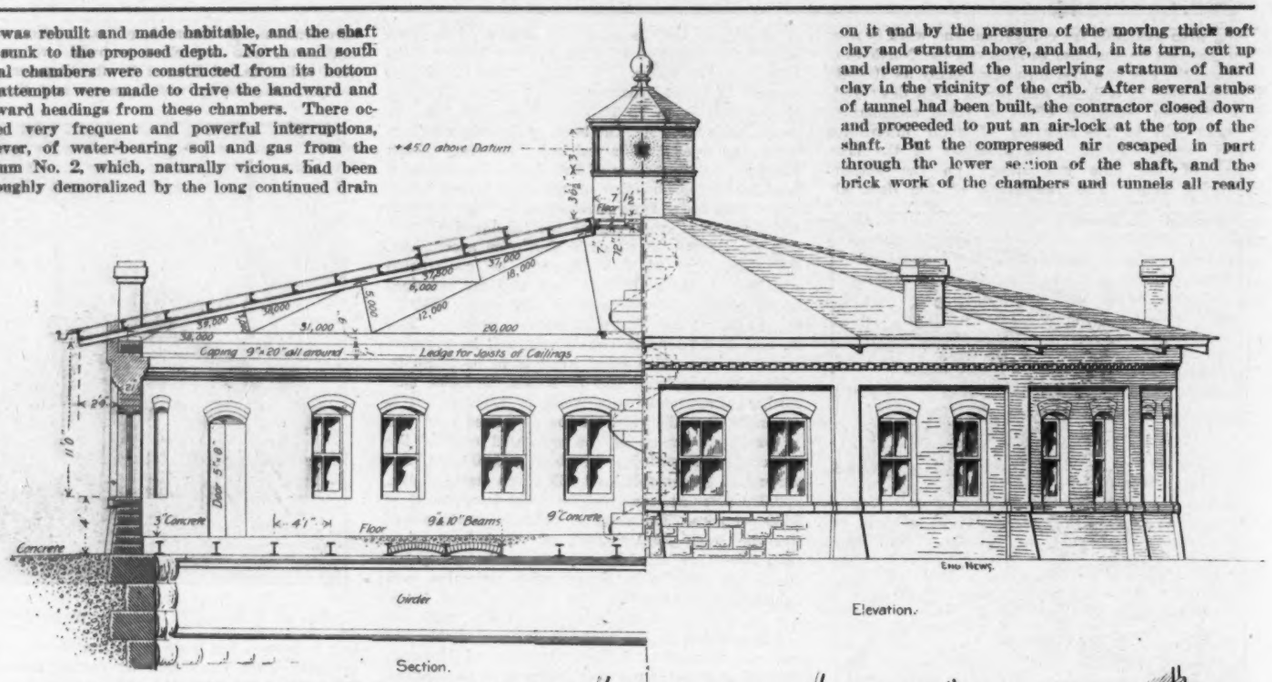
This novel affair proved to be an almost total loss to the contractor, having miscarried in the very launch. Thereupon, a pentagonal timber and stone crib was built, and set in place on the lake bottom. A 10-ft. cast iron shaft was sunk inside, and all went well until the water-bearing stratum No. 2 (See Eng. News, Sept. 8), was reached. Its immense outflow followed the shaft all the way down by cutting channels under the shoe, even after its original thickness had been pierced. Its consequent shrinkage lowered the overlying soft clay stratum and with it the lake bottom and the crib. Some cross-timbers in the well of the moving crib



THE 4-MILE CRIB, CHICAGO WATER-WORKS.

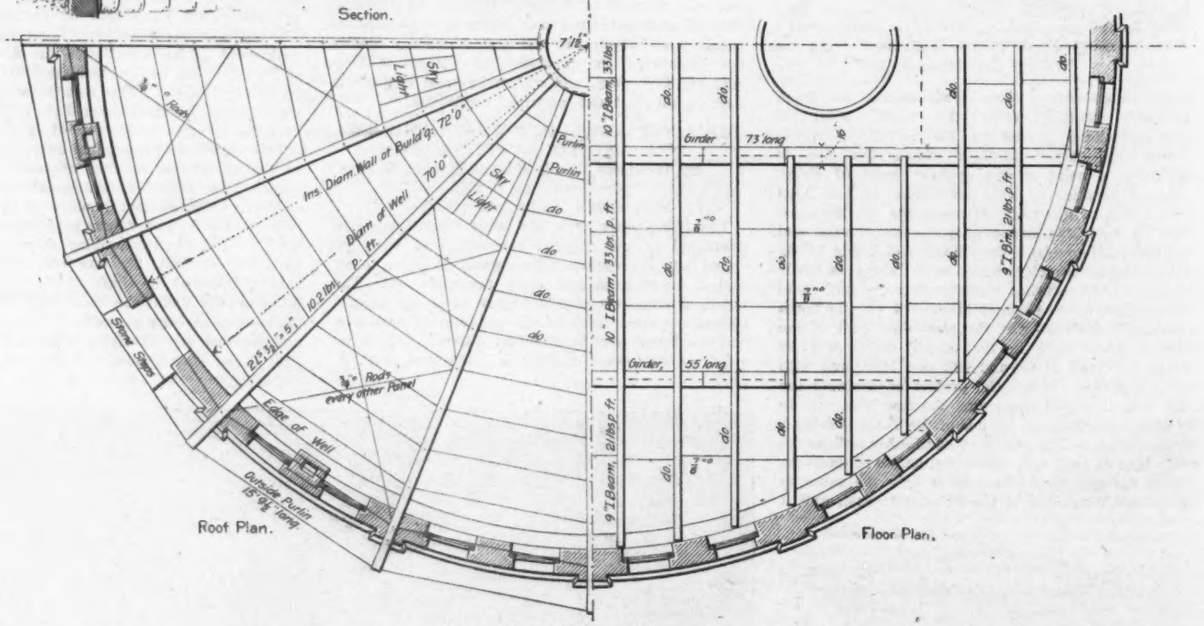
The 2½-mile, or intermediate crib par excellence, with its shaft, was embraced in the original contract. It was provided in order to expedite the tunnel work by adding two headings, but it failed of its purpose absolutely and has no connection whatever with the lake tunnel now completed. The came into contact with the cast iron shaft and broke it. The superstructure, being pulled down so near to the lake level, was several times destroyed by seas in storms. By numerous expedients, for a description of which, however interesting, there is no room in this short article, the

crib was rebuilt and made habitable, and the shaft was sunk to the proposed depth. North and south lateral chambers were constructed from its bottom and attempts were made to drive the landward and lakeward headings from these chambers. There occurred very frequent and powerful interruptions, however, of water-bearing soil and gas from the stratum No. 2, which, naturally vicious, had been thoroughly demoralized by the long continued drain on it and by the pressure of the moving thick soft clay and stratum above, and had, in its turn, cut up and demoralized the underlying stratum of hard clay in the vicinity of the crib. After several stubs of tunnel had been built, the contractor closed down and proceeded to put an air-lock at the top of the shaft. But the compressed air escaped in part through the lower section of the shaft, and the brick work of the chambers and tunnels all ready

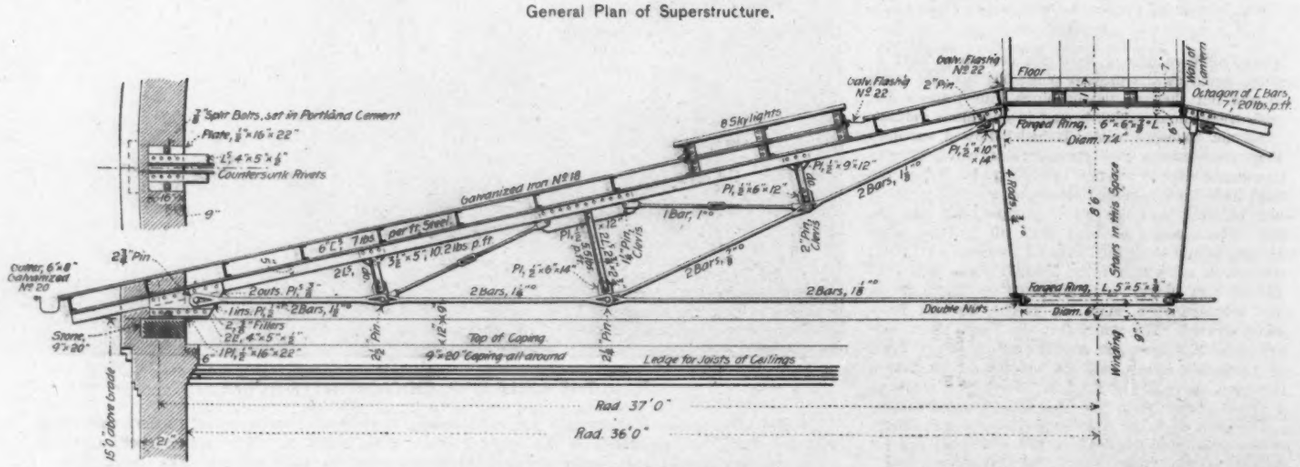


Elevation.

Section.



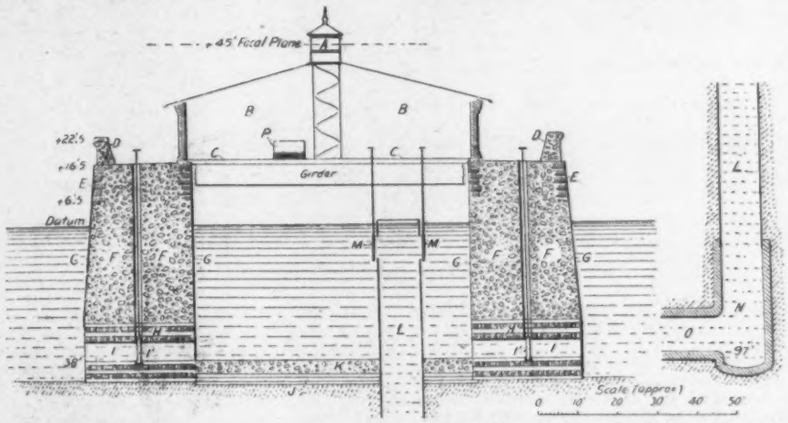
General Plan of Superstructure.



Details of Roof Truss.

THE 4-MILE CRIB, CHICAGO 4-MILE TUNNEL.

built was found to be in a state of collapse. The natural viciousness of the soil, which was first increased by the downward movement of the strata as explained above, had been further enhanced by compressed air escaped from the shore headings through the continuous water-bearing stratum No. 2. The chambers, tunnels and the lower section of the shaft were then filled up with concrete, and a new 6-ft. tunnel was begun under air pressure, on the grade of the shore headings, or about 20 ft. higher up, in the hope that in consequence of the sinking of the soft clay stratum the cross section would be entirely in the latter. Such, however, was found not to be the case, and after the contractor had built 47 ft. of the upper level tunnel, he retired in August, 1891, and ever since the crib has stood, and still stands, useless, desolate and decaying.



A. Light. B. House.
C. Floor—steel beams and brick arches. D. Parapet wall—high grade concrete.
E. Granite facing. F. Concrete filling.
G. Steel shell. H. Timber grillage.
I. Ports; 1' port-gates. J. Well bottom—timber. K. Well bottom—concrete. L. Upper shaft—cast iron.
M. Shaft gates. N. Lower shaft—brick.
O. Tunnel—8-ft. single heading.
P. Air compressor and blow pipe.

SKETCH SHOWING VERTICAL SECTION OF 4-MILE CRIB AND SUPERSTRUCTURE, CHICAGO 4-MILE TUNNEL.

The four-mile or intake crib and shaft were a success from beginning to end. An outline vertical section of the structure, as it will appear when finished, is shown in the sketch herewith. For the substructure reference is also made to issue of July 5, 1890, and for the superstructure to the accompanying illustrations. The substructure had been finished and the shaft had been sunk by Nov. 1, 1890.

Work on the superstructure has begun. Compressed air released near the mouth of the ports will be depended upon in winter to prevent the formation of anchor ice and the choking up of the ports. The excavation from the four-mile heading has been dumped over the side of the crib and has partially blocked up the ports. It will be removed by dredging. When this dredging and the cleansing out of the tunnel shall have been done, the tunnel will be ready for service. This is expected to occur before the first of October of this year.

A description of the new land tunnel system and the two new pumping stations fed by them will be given in a subsequent article.

(To be continued.)

COST OF CONCRETE IN HARBOR WORKS.

In a short article on "Concrete in Harbor Works," "Engineering" summarizes the works of this description more or less fully described in its past issues. This summary is useful and is as follows, with values in English money:

	Quantity deposited per year.	Approximate cost of required plant.	Cost of materials and labor per cubic yard.	Lifting, transporting, depositing, including maintenance of plant and cost of staging per cubic yard.	Proportion of cost of plant at end of ten years' work per cubic yard.	Total cost per cubic yard.
	c. yds	£	s. d.	s. d.	s. d.	s. d.
Aberdeen...	6,336	20,000	13 0	3 0	7 9	23 9
Brest.....	21,240	4,000	15 8	0 19	0 6	17 0
Dublin.....	6,000	26,000	19 8	4 4	10 0	34 0
Kurrachee..	12,500	10,500	17 5	4 4	2 2	23 11
Colombo....	15,000	13,000	...	....	21	41 7
Rosslare	4,400	2,000	10 0	4 6	11	15 7
New Haven.	15,000	.....	...	....	...	22 4
Blythe	.....	.....	...	....	...	17 9
Wicklow....	.....	.....	...	....	....	21 6
Fraserburgh	8,000	.....	...	....	...	22 0

THE HUDSON RIVER TUNNEL AND ITS ENGLISH ENGINEERS.

In our issue of Aug. 25 we commented upon the great increase in cost of the Manchester Ship Canal over the engineers' estimates and upon the general excessive cost of engineering works carried out by English engineers at home and abroad. The "Financial News," of London, in referring to the unfortunate experience of the Manchester Ship Canal, pointed out that the estimates of Sir John Fowler and Sir Benjamin Baker, the consulting engineers, of the cost of completion of the Hudson River Tunnel have also been exceeded, though in this case it was owing to the adoption of a new system of construction not included in their estimates. But, as the English papers say, it certainly seems strange that the consulting engineers, on the strength of whose names and reputation subscriptions for the bonds were obtained in England, did not find out at once the impracticability of the former plan. It would seem that when the bond issue was made neither Sir John Fowler nor Sir Benjamin Baker had visited the works, as, if they had done so, they would hardly have allowed the construction of the tunnel to be proceeded with on a system which they declared later to be "dangerous to the safety of the tunnel and to the workmen employed in constructing it." The actual result seems to be that the funds supposed to be sufficient to make the two tunnels have proved insufficient to make even one of them. Some interesting details of the tunnel project and the cost in lining of the tunnel were given in our issues of June 16 and 30, 1892. At a meeting of the Hudson Tunnel Railway Co., in London, Aug. 11, Sir Benjamin Baker made a statement in regard to the connection of himself and his partner, Sir John Fowler, with the enterprise, which we abstract as follows from a report in the "Financial News":

In December, 1887, they were asked by some lawyers and others if they thought the tunnel could be completed for the sum stated by the American contractor, namely, $900,000 for one tunnel and $1,200,000 for another. They had had a great deal of experience in connection with tunnel work, but took the advice of other eminent European engineers who had had very great experience in this matter. He got particulars from people who had carried out some 30 different works of a like character, and also from one of the most experienced contractors in France. It was on the face of the advice given by those gentlemen that he had made his first estimate as to the cost of completing the Hudson tunnel; but they had told the American contractors that if they went about the work in the proper manner they could complete it for the estimate given. He also told the contractors that they must not make any use whatever of that estimate, because he did not know that a single foot of the tunnel had been made. In April, 1888, about three or four months afterward, he went to New York and inspected the tunnel, and examined the whole of it carefully; in fact, in a certain portion of it he risked his life, in order to make as accurate an estimate as possible. He did not know the cost of labor in America, but he went into the books of the American contractor, and took the cost price of everything, including the wages paid to the men and the coal burned. He then made an estimate which came out practically identical with the estimate previously given. It was not until he had done all that, and conferred with his colleagues, that they wrote a letter in which they gave an estimate of the cost. They were simply consulting engineers, and Sir Horace Davey had said that a consulting engineer was a man who could be consulted, but had no authority to insist on his advice being followed. At the time the works were stopped at the tunnel, and about six months previously, the construction was being carried on practically at the cost of their estimate, and it was being carried out 50% faster than they estimated.

The excessive costs arose simply at the beginning, and although it might appear presumptuous on his part, he would say it arose very largely from their advice not having been accepted. They had no power to enforce their advice; but they were satisfied exactly as to the manner in which the work should be done. He advised the American contractors to start the shield system, and not to use the old plan. He informed them that if they used the old plan they would have the river in the tunnel. His advice, however, was not taken, and the result was that the river broke into the tunnel. This was how so large an amount of money had been wasted. As regarded the work itself, he had not been out there for two years, and the estimate of the work as completed was prepared by the chief engineer, who was in daily superintendence, and he had no reason to doubt his figures. Before they accepted the post of consulting engineers, they said it was impossible for them to superintend a work 3,000 miles away; but they would accept the position if an engineer of admitted reputation and experience were appointed. Mr. Hutton, an eminent engineer, whose name stood as high as any engineer in the United States, was appointed. He did not mean to reflect in any way upon the men for not following his advice, because they were the responsible people, and if they saw a better way of carrying out the work, of course they ought to follow it. The evidence showed that when they followed his advice the estimate was right, and that when they did not the estimate was all wrong. He might say, as regarded his personal position, that he went out to New York and made an inspection of the work, and he had not received a single penny piece so far for what he had done; in fact, they had spent their money for cablegrams and other matters, and were £4,000 or £5,000 out of pocket. Their position had been a purely honorary one. He believed that if this difficulty had not occurred the tunnel would have been completed long ago. The total completed length of the tunnel, according to the returns furnished by the chief engineer, was 3,916 ft. on the New Jersey side, and there were 1,684 ft. still left to be finished. The chief engineer estimated that it would cost another $750,000 to complete the construction.

In response to a query, however, Sir Benjamin stated that he expected to be paid by the company, as is very natural.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Liability for Bridge Over Railroad Track.

Where a railroad company is bound to maintain a highway bridge over its tracks, it is liable to one injured by the defective maintenance of the bridge, and such liability is not negatived by the fact that the injured party might have sued the township for failure to keep the highway in repair. (Gates v. Pennsylvania R. R. Co. Supr. Ct. of Penn., 24 At. Rep., 638.)

Submission of Disputes to Engineer.

The two parties to a contract having agreed, in case of disputes or differences as to the construction of their contract, or the sufficiency of the performance of any of the work to be done under it, or the price to be paid, to submit them to the civil engineer in charge, who was to consider and finally decide them, are bound by the measurements made, and by the decision of the selected arbitrator. But the hasty utterances of the arbitrator, without knowledge of all the facts, cannot be construed as modifying or changing the terms and conditions of a contract, one of the clauses of which reads: "No extension of time or alteration of this contract is in any way to be considered or allowed, unless the same be in writing, properly signed by the parties and attached to the agreement." (O'Donnell v. Forrest, Supr. Ct., La., 11 Southern Rep., 245.)

New York Drainage Law Unconstitutional.

Laws 1867, chapter 372, entitled "An act to provide for draining certain swamp lands situated in" certain towns, appointed three commissioners, and provided that they should estimate the cost of such drainage, and assess and apportion such cost on the owners of the lands to be benefitted; that these assessments should be a lien on the lands assessed; that the commissioners should publish a notice of the assessments, appointing a time and place at which such assessments would be received by them; and that, unless such assessments should be paid at the place and time so appointed, they should then and there proceed to sell to the highest bidder at public sale the lands assessed. This is unconstitutional, because it seeks to deprive the owners of such land of their property without due process of law, in that it gives the owners no opportunity to resist the assessment. This act also provides that the commissioners may enter on any lands in or about a certain swamp for the purpose of constructing, maintaining and repairing ditches thereon, and is therefore unconstitutional for the further reason that it seeks to take private property for private use without consent of the owner. (People v. Henion. Supr. Ct. of N. Y., 19 N. Y., Sup., 488.)

THE HAWARDEN BRIDGE OVER THE RIVER DEE, ENGLAND.

We give below an abstract of an interesting paper by Mr. Francis Fox, M. Inst. C. E., describing a recently built railway bridge having a draw span of 140 ft. clear opening. The paper is printed in the minutes of the proceedings of the Institution of Civil Engineers, from which the accompanying illustrations are reproduced.

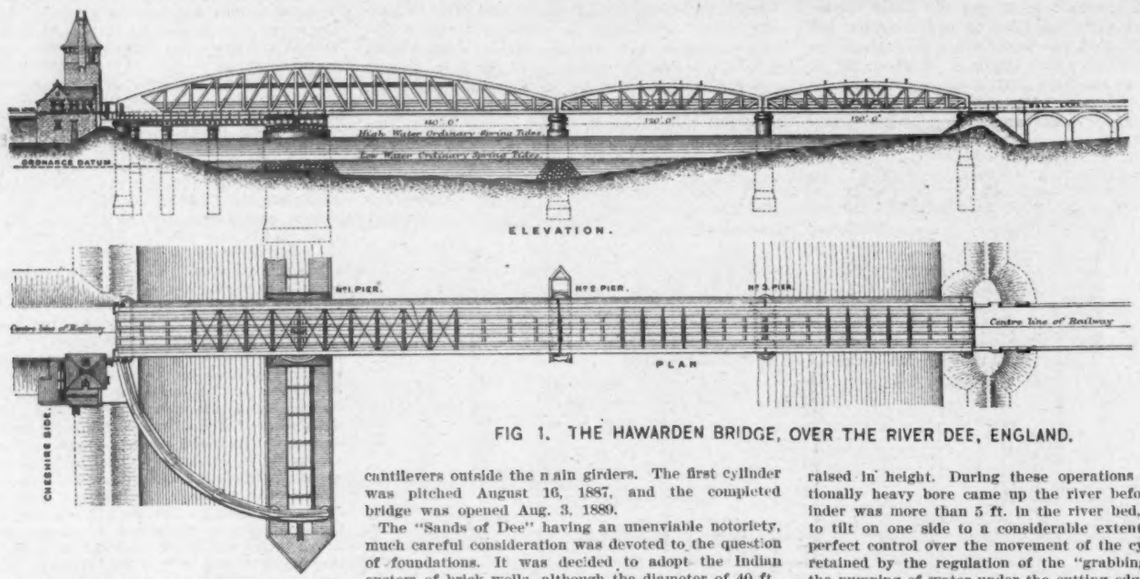


FIG 1. THE HAWARDEN BRIDGE, OVER THE RIVER DEE, ENGLAND.

Owing to the physical conformation of the estuary of the River Dee, the swing portion of the Hawarden bridge over it was required to be the largest opening span in the kingdom, namely, 140 ft. clear opening, as compared with Leith docks, 120 ft.; Tyne bridge, two spans of 110 ft.; Ouse bridge (Northeastern Ry.), two spans of 100 ft.; and Ouse bridge (Hull & Barnsley Ry), two spans of 100 ft.

The available width of the river at the site of the bridge is only 450 ft., owing to the land having been reclaimed, and the river canalized. Consequently the flood-tide is preceded by a "bore," or tidal wave, sometimes 3 to 4 ft. in height.

The Act of Parliament for the bridge was obtained in 1888, by the Manchester, Sheffield & Lincolnshire Ry., the author being shortly afterward appointed chief engineer, both for this work, and for the connecting railway from Chester to the bridge.

The bridge consists of two fixed spans of 120 ft. each, and of one swing portion, 287 ft. in length over all, which gives two unequal openings, the largest of which, being for navigation, is 140 ft. clear span, while the tail-end of the girder gives a clear span of 87 ft., as shown in Fig. 1. The bridge carries a double line of railway, with a footpath 4 ft. in width, supported on cantilevers outside the main girders. The first cylinder was pitched August 16, 1887, and the completed bridge was opened Aug. 3, 1889.

The "Sands of Dee" having an unenviable notoriety, much careful consideration was devoted to the question of foundations. It was decided to adopt the Indian system of brick wells, although the diameter of 40 ft., required for the center turntable, was large for this system. Difficulties having arisen in other swing-bridges, in consequence of the center race and pivot having been placed on a group of cylinders which settled unequally, it was decided to have only one cylinder, sufficiently large to take the central race. A wrought iron caisson was provided, having a cutting ring, 43 ft. diameter, consisting of ½-in. plates riveted together, with a special rolled section of iron, forming the actual cutting edge, inserted between them. These plates rise vertically for a height of 9 ft. outside; but, internally, they slope upward toward the center of the cylinder, until, at a height of 9 ft. above the bottom edge, they are reduced to a diameter of 30 ft. This gives the shoe of the cylinder the necessary form for sinking, and provides an annular space, 5 ft. wide, between the two skins of the caisson, which was filled with cement concrete made 5 to 1. To avoid the expense and delay of tide work, and in consequence of the impossibility of making an artificial island, as in the case of Indian bridges, the iron plating was brought up 24 ft., sufficiently high to reach above high-water mark, when the cylinder was lowered on the bed of the river. Directly this operation was completed, the annular space was filled with about 200 tons of concrete; and a circular wall of brindle bricks in cement, 5 ft. thick, and having an internal diameter of 30 ft. was carried well up above the water-level. Dredging with a grab (or clamshell) was then commenced inside the cylinder; and as the material was removed, the cylinder gradually sank, and the brick walls were raised in height. During these operations an exceptionally heavy bore came up the river before the cylinder was more than 5 ft. in the river bed, causing it to tilt on one side to a considerable extent; but such perfect control over the movement of the cylinder was retained by the regulation of the "grabbing," and by the pumping of water under the cutting edge, that this tilting was utilized to keep the cylinder in true line, both longitudinally and crosswise. Although the weight of the mass was 2,300 tons, it could be adjusted to a nicety, and when finished was within half an inch of its true position. The weight on the cutting edge of the cylinder, at the commencement of the sinking, was about 6 tons per lin. ft., which was increased by the addition of the brickwork as the cylinder descended. When the cylinder had reached the requisite depth of 48 ft. below the bed of the river, the bottom was levelled by the grab, or by a diver when necessary, and was concreted under water, by means of "pigeon-trap" boxes, to a depth of 18 ft., with strong concrete in cement; so as to withstand the hydrostatic pressure. As soon as this concrete had set, sealing the bottom of the cylinder, the water was pumped out, and the remaining height was concreted in the dry. At the height of 17.50 ft. above Ordnance datum, or 18 ins. above high-water mark, a floor of brickwork in cement was laid over the whole surface. The masonry for the race, and the block of granite, 9 ft. square by 3 ft. thick, for the central pivot, were then fixed. The same system was adopted for most of the other cylinders, although they were of smaller diameter, and

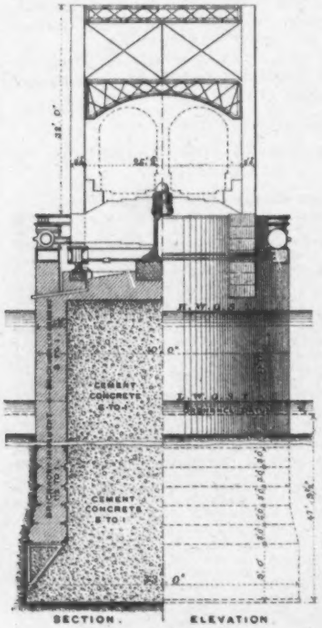


Fig 2. Pier No. 1.

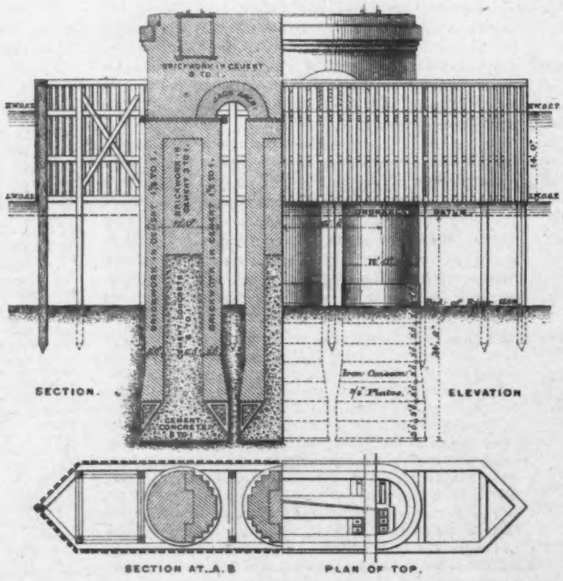


Fig. 3. Pier. No. 2.

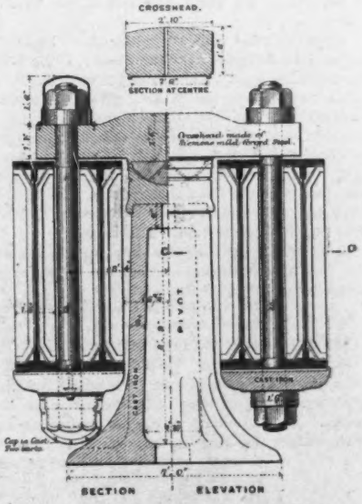


Fig 5. Pivot, Crosshead and Bolts.

would have been for all, had the diameter, in all cases, been sufficient to allow the grab to pass down inside the brick wells.

The Cheshire abutment and No. 3 pier each consist of two brick cylinders, 12 ft. to 10 ft., and 14 ft. to 12 ft. diameter, united together above the water-level by an arch of brickwork in cement. No. 2 pier has three brick cylinders, 14 ft. to 12 ft. in diameter, connected by brick arches, on which are fixed the masonry and bed-plates for receiving the fore end of the swing girder. The cylinders for the tail race, being only 8 ft. to 6 ft. diameter, are of cast iron, and, after being sunk by grabbing, were concreted, and capped with brickwork. The cylinders were weighted with a test load of 50% more than the permanent load, without movement.

A large timber fender protects the swing girder from vessels passing through the bridge; and the piles for this were sunk by aid of water-jets, a system inaugurated by Sir James Brunlees, Past-President Inst. C. E.,* many years since, and subsequently employed at the Calais harbor works, but not often adopted. The piles are cut off square, thus offering a flat surface for the weight to rest upon. A 2-in. pipe is temporarily spiked to the side of the pile, which is then pitched in its place; this pipe is connected by a flexible hose to a steam-pump, and water being pumped through it, is discharged immediately beneath the pile, thus rendering the sand "quick"; and so long as pumping is continued, the pile sinks as quickly or as slowly as desired. As soon as the required depth is reached, and before the pumping is stopped, the pile is easily drawn into proper line, or rotated until square to the wulings; and so accurately can the piles be sunk by this system, that all the bolt-holes are bored through the piles before they are pitched. When it is finally in proper position, the pumping is stopped; and the 2-in. pipe is drawn from the pile and used again for the next. By this system, a pile can be sunk 20 to 25 ft. in sand in two minutes, without the delay, uncertainty, or damage which so frequently accompany the ordinary system of pile-driving. Sometimes a nodule of clay, or erratic boulder of the glacial drift is encountered by the pile; but by sinking another pipe down to the level of the underside of the stone or nodule, and pumping, the obstruction sinks away in advance of the pile which rapidly follows. Within half an hour of the pumping being stopped, the sand settles round the pile, and no amount of ordinary pile-driving will stir it a fraction of an inch.

The same system of "washing-down" was employed under the cutting edge of the 40-ft. cylinder; and this system is capable of various applications in connection with the sinking of foundations. By providing for jets of water round the cutting edge of cylinders, and at intervals up the entire height of the caisson, the process of sinking is greatly facilitated and accelerated, the skin friction being reduced to almost any desired extent.

The swing bridge consists of two main girders, constructed of mild steel, each having a total length of 284¾ ft., and a total depth at the pivot of 32 ft., and 9½ ft. at the ends. The pivot is 116½ ft. from the tail end, and 168¼ ft. from the fore end of the girder. The girders are 27½ ft. apart, c. to c.; and the clear width inside is 25 ft. 2 ins. The girders are lattice, divided into panels, 17 ft. wide, with single, triangulated, vertical and diagonal members, except over the pivot where the members cross each other. The top chords are curved and bow-shaped, and the bottom chords are horizontal. The sections of the various members are of the simplest form, the connections being made by junction plates and rivets; and smith's work was avoided wherever possible. The bottom chords are of a square trough section, and the top booms are the same, but inverted. The lattice members are of I section, made of plates and angle-irons, and are, therefore, capable of resisting compressive strains, which is important, as the strains alternate with the opening and closing of the bridge, and with the passing of the load. This system, together with an efficient method of cross bracing, has, it is believed, prevented the girders from becoming distorted, which, if it took place in consequence of changes in temperature or other cause, would render the fitting of the bridge difficult. No trouble in this respect has been experienced; and the girders have exhibited a highly satisfactory rigidity and stiffness.

The track is carried upon cross girders, 28 ins. deep over the angle-irons, and 17 ft. apart, fixed to the bottom chord of the main girders, and in line with their vertical members, to which the cross girders are also attached by a peculiarly shaped gusset or corner bracket. The latter, in addition to its primary object, carries a very convenient platelayers footway, and also supports the rail guard required by the Board of Trade. The rails are borne on ordinary chairs, fixed upon longitudinal timbers, 16 × 5 ins., which are carried by steel-plate girders, or rail-bearers, 22½ ins. in depth, whose ends are fastened to the webs of the cross girders. The rail-bearers are stiffened and tied together and to the main girders, by steel T irons at intervals of 4¼ ft. The latter also form bearers for the floor, which consists of bars, ¼ in. thick, with spaces between to prevent accumulation of ashes or snow, and to permit the wind and rain to pass through. The component parts of each member were made in one piece without joint, so as to reduce the dead weight as much as possible, which, combined with the economical pitch and depths of the cross girders and rail-bearers, has produced a very light and strong platform. The weight is 38 lbs. per sq. ft., including the corner brackets and gangway plates, but exclusive of the track. In building the main girders, the manufacturers were instructed to set them out and erect them without camber; and the bottom chords were accordingly laid and fixed level. The deflection which would ensue when the longer end of the girder is unsupported, was calculated; and provision was made in the lifting apparatus at the tail-end, to take out this amount of deflection, and bring the girder back to its normal level, and thus free it, as much as possible, from stresses due to its own weight, when in position to carry the railway traffic.

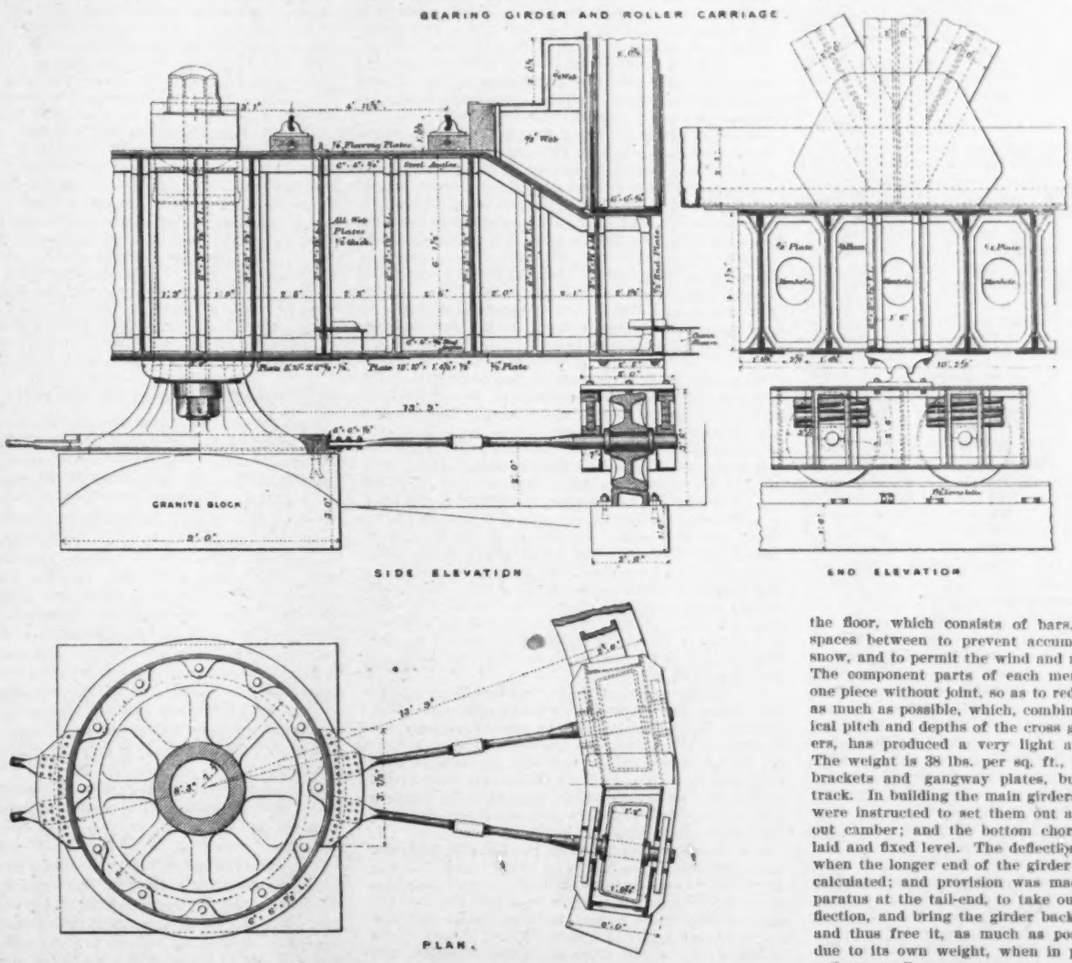


FIG. 4. BEARING GIRDER AND ROLLER CARRIAGE, HAWARDEN BRIDGE.

The swing span, in addition to its rotary motion, is arranged with a slight bascule movement, for the purpose of lifting the fore ends of the main girders out of their bearing sockets. This movement is effected by lowering the tail-end, which is made to preponderate to the extent of about 15 tons, partly by means of the balance weight, and partly by the weight of the tail rollers, etc. The drop at the tail-end is 8 ins., which, if the girder was not elastic, should cause a corresponding elevation at the fore end of 11½ ins. The rise of the fore end from the bedplate is actually 8 ins. on the average, the difference of the two dimensions being the deflection of the girder, namely, 3½ ins. The lifting apparatus at the tail-end, consisting of a pair of vertical single-acting hydraulic rams, 25 ins. diameter and 8¾ ins. stroke, one fixed under the end of each main girder on the Cheshire abutment, has not only to lift the 15 tons preponderance, but also the much greater load due to the resistance of the girders to being straightened. This is slight at first, but rapidly increases until a maximum of 200 tons is reached, as ascertained by experiment. The rams have a total lifting power of 300 tons.

With the exception of the small preponderating portion of the balance above referred to, the entire weight of the swing span and balance, amounting to about 732 tons, is carried by the pivot cross-bearing girder, the

* Minutes of Proceedings Inst. C. E., vol. xvii. P. 444, and vol. xx. p. 294.

weight being equally disposed at each extremity and transmitted to the center. The girder, 30 ft. long, is divided into four equal sections, 6½ ft. in depth, and 1 ft. 4½ ins. in width. The girder is suspended at the center by two large steel bolts, 10¾ ft. long, with a minimum diameter of 9 ins., and having special screwed nuts, by which the whole weight of the swing span can be raised and lowered for adjustment (Fig. 5). The bolts are suspended at each end of a steel crosshead (8⅝ ft. × 2 5-6 ft. × 1½ ft.), 5¾ tons in weight, which rests upon the pivot. The crosshead passes over the bearing girder, the top of which is level with the deck of the bridge; and it is therefore visible in the 6-ft. way, and, together with the upper ends of the suspension bolts, is accessible therefrom. By this arrangement all adjustments can be effected, and the pivot can be readily examined, or entirely removed and replaced, without interfering with the railway traffic. This, moreover, raises the level of the pivot, which is thus brought as near as possible to the center of gravity of the moving girder. By dividing the bearing girder into four parts, the pillar which carries the pivot passes up between the two center portions, and the bolts descend between the two outer sections, thus distributing the weight equally among the several members.

The bolts and crosshead are made of hammered cast steel, and every precaution was taken to insure their soundness; and after being machined and finished, they were tested with a strain of 1,000 tons. The working load on the couple is 732 tons, and the estimated breaking load is 3,500 tons. The threads of the bolts are of the saw-tooth pattern; the bearing surfaces are horizontal, and therefore no bursting strain or wedge action is exercised on the nuts, and large bearing areas are provided on the threads. The nuts have been screwed on and off many times, with the entire load upon them, and the threads remain quite perfect. In the remote contingency of the bolts and cross-head failing, the entire load would descend upon the steadying rollers, which are capable of carrying the bridge round independently of the pivot. If these again were to fail, the bridge should descend 1 in. and rest upon the parapet of the main pier, which is a solid ring of brick-work and iron-work, 40 ft. in diameter. A solid bearing pivot was adopted in preference to a hydraulic ram, or water bearing, as, the necessary vertical movement of the bridge having been provided for, a ram was not required. Moreover, several disasters have occurred in connection with water bearings in this country and abroad, and leakage is also liable to occur. The form adopted is a cup and ball, 30 ins. in diameter, each part being made of forged wrought iron, and the wearing surfaces case-hardened; and it provides for both the rotary and bascule movements of the bridge (Fig. 5). The weight on the pivot, when the bridge is being opened, is 732 tons, which would be equal to a load of one ton per sq. in. of bearing surface, if the entire surfaces were in contact; but as the radius of the cup is ¼ in. larger than that of the ball, which is 19½ ins., the weight per sq. in. is very much greater at the center. The lubricant used is heavy cylinder oil, heated to make it fluid; and it is injected on an average once for every three times the bridge is opened, the consumption of oil being about ½ gallon per week. The bridge is opened about 11 times per week.

The two rams for opening and closing the bridge are fixed upon massive cast iron bed plates built into and bolted down to the solid brick-work of the main pier. They are laid horizontally, and parallel to the longitudinal axis of the bridge, at a distance of 18 ft. on each side of the pivot. Both rams are single acting, and are geared with chains in the proportion of 2 to 1; and one ram opens, and the other closes the bridge. One end of each chain is fixed to the head of each cylinder; the chain then passes over a sheave, 4 ft. in diameter, fixed upon the head of the ram; and the other end is attached to a large drum or sheave, 32 ft. in diameter, which forms part of the main bearing girder. The rams are thus in direct connection with the swing span, and also with one another; and they therefore act in unison, one coming in as the other goes out.

Fixed upon the top of each cylinder, and automatically worked by the movement of the rams, is a water brake, designed by Mr. Frank Pearn, for the purpose of gradually starting and arresting the movement of the bridge. The man in charge may open the starting valve full bore, and leave it so after the arc of rotation has been completed; but by means of this apparatus, the movement is beautifully controlled, the great mass is put into motion slowly, its speed increases, and at the end of its travel is arrested without the smallest vibration or tremor. This is effected by admitting the supply through a hollow tubular piston, in which are about 60 holes, ⅛ in. diameter, only a few of which admit the water to the cylinder at the beginning of the stroke, while the remainder are gradually uncovered as the travel proceeds. The action is reversed in the opposite cylinder, the exhaust being throttled to bring the span to a standstill.

Four rollers of cast steel, 3 ft. in diameter, are provided, two under each end of the main bearing girder, and directly under the main girders on the pivot pier (Fig. 4). The rollers revolve in a wrought iron carriage, upon fixed radial axles, which are centered to, and turn round the base of the pivot pillar. They travel upon a cast steel track arranged in two quadrants, 13¾ ft. radius, fixed to the solid brick-work of the pier. Each axle has two bearings, one inside and one outside the roller; and above each bearing is a pair of long steel wedges, by means of which the weight can be either entirely removed from the rollers, or increased so as to take the total load of the bridge, in the event of the load being removed from the suspension bolts. In practice, however, the total vertical load is carried by the bolts; and the rollers take only the lateral pressure caused by the action of the wind upon the main girders.

Two cast steel rollers, 3 ft. in diameter, are placed at the tail-end of the main girders, one under each girder, which carry the preponderating load only, which is about 15 tons. They are fixed in frames attached to the outer side of each girder, and travel upon a cast steel track, having a radius of 115 ft., through an arc of 90°. Each roller is fitted with a winch gear and brake, in order that the bridge may be opened and closed by hand, in the unlikely contingency of the hydraulic gear getting out of order.

When the bridge is being closed, the bascule movement is utilized, not only to bring the span into true line, but also to lock it securely in position. The lifting rams raise the tail-end of the span, which is provided with a tapered projection entering into a corresponding slot fixed to the abutment; and at the same time the fore ends of the main girders fall into cast iron bedplates with tapered sides. When this has taken place, solid cast iron bearing blocks are inserted underneath the girders at the tail-end. These blocks are also given a slight taper on the sides, and fit into corresponding bedplates attached to the girders above them and the abutment below. The top and bottom faces of the blocks are parallel to each other, as no lifting movement is required of them. The rams lift the tail about ⅛ in. higher than the normal level, in order that the blocks may enter freely. These blocks are moved by a hand wheel and gear, similar to a steering wheel placed in the tower. Provision is made for working this gear by hydraulic power; but it was thought desirable at the outset, that this final essential operation of mechanically fixing the bridge should have a more sensitive connection with the man in charge than hydraulic power can afford. If anything went wrong with the apparatus, which is out of his sight, the blocks would not enter, and he would immediately feel it, which would not be the case if he simply had to turn a tap. An index on the wheel shows him when they are home; assuring him that everything is in perfect order, and that the bridge is absolutely true line and level. It is his interest to see that the blocks are kept clean and well oiled.

The bascule movement is again utilized for automatically closing the space, which would otherwise occur, between the ends of the rails on the moving and fixed portions of the bridge. An apparatus at each end, as the bridge closes, causes the rails to move forward until they meet, thus enabling trains to go over at full speed. The same movement automatically closes a gate on the foot path, thus preventing persons walking into the river when the bridge is open.

Both the steam and hydraulic plant are in duplicate. There are two steam boilers of 12 HP. each, and one of 25 HP., of semi-portable multitubular type, and having a working pressure of 70 lbs. The two vertical double-acting steam pumps, built by Frank Pearn & Co., have each a pair of cylinders 12 ins. diameter and 10 ins. stroke, a pair of rams 3¼ ins. diameter, and a pair of balance rams, 2⅝ ins. diameter. The two accumulators have each rams of 20½ ins. diameter and 14-ft. stroke, weighted with 92 tons of cast iron cylinder weights to give a pressure of 700 lbs. per sq. in. The capacity of each accumulator is sufficient to open and close the bridge once without replenishing; and each pump is able to raise an accumulator to the top of its stroke in 10 minutes. Both the pumps and accumulators are provided with automatic starting and stopping gear. In case of an accident to a pipe, causing the water to escape with undue rapidity, the accumulator is provided with a throttling arrangement which would prevent it falling with any dangerous speed. The accumulators are placed in a tower, on the upper floor of which the man in charge stands, and has a good view of the bridge, the river, and the railway, and where all the hydraulic pipes are led to a controlling valve, a compact apparatus made of gun metal. The pressure not being excessive, and the water used being clean, a slide valve was adopted, which simplifies the working parts and reduces the number of levers, so that only two are required, one for opening and one for closing the bridge.

All the important moving parts of the bridge are electrically interlocked with the signals, so that until everything is exactly in its place, and the bridge ready for traffic, the signals, not only on the bridge, but also at the stations on both sides, cannot be lowered. In order to open the bridge, permission has first to be obtained from the signal boxes, which can only be given when all the signals are at danger. This permission releases the key lever in the bridge tower, the movement of which back-locks the signals at the boxes. The operations are then as follows: 1. Lifting the tail-end of the bridge ⅛ in. by the tail-end rams; 2. Withdrawing the sliding bearing blocks from under the tail-end; 3. Lowering the tail-end rollers; and 4. Setting in motion the rotating rams. The proper sequence of these operations is secured by electrical contacts placed in different parts of the bridge, so that no fresh movement can be made until the preceding one is completed. Without this provision there might have been the dangerous possibility, at night time, of the rotating rams being set in motion before the bridge was lowered on to its race. The time occupied in opening the bridge, from the moment of the first intimation that a vessel has to pass through till the bridge is full open, is two and a half minutes.

The steel in the girders is calculated to carry, under its greatest load a strain of 6½ tons in tension and 5 tons in compression. The steel was made by the Steel Co. of Scotland, and gave remarkably uniform results, the average being 31 tons per sq. in. breaking strain, 49.30% elongation in 10 ins., and 22.36% contraction of area. The bridge was inspected on behalf of the Board of Trade, by Lieut.-General Hutchinson, R. E. The test load consisted of six of the heaviest locomotives and tenders, weighing altogether 427 tons. The greatest deflection on the swing span was 0.72 in.

The total cost of the bridge, including all extras and duplicate parts, was $355,000, equivalent to $545 per lin. ft. The contractors for the whole work were John Cochrane & Sons, of Westminister. The sub-contractors for the superstructure and the hydraulic machinery, were the Horseley Co., of Tipton, Staffordshire. The details of the bridge were in great measure designed by Mr. G. A. Hobson, M. Inst. C. E.; and the Resident Engineer was Mr. S. B. Cottrell.

THE WIDTH OF WHEEL TIRES IN CITIES.

The subject of the width of wheel tires as compared with loads carried on omnibuses, heavy drays, etc., moving over the paved streets, is brought to the attention of the city authorities of Philadelphia, by Mr. James H. Windrim, Director of Public Works, and Mr. Windrim details some bits of practical experience in this line that will be of interest to municipal officers elsewhere. He says that the omnibuses running on Broad street, in Philadelphia, have an average tire of only 2½ in. During the repaving of Broad street, at an expense of $204,643 in 1892, this omnibus traffic was diverted to side streets with lighter pavements. The result was that in 14 days damage to the amount of $6,000 was done in displacing paving, broken crossing stones, sewer manholes and stop-boxes for gas and water. This all happened in an area of 16,635 sq. yds. of street pavement.

It is altogether probable that the damaged side street referred to was of the more antiquated type of street paving in that city and was stone laid on an earth foundation. But undue concentration of load should also be avoided in the traffic over a modern pavement with a concrete base, and its greater first cost is only an argument for its better preservation. We pay altogether too little attention to the subject of tire-width, both in our cities and in the country, and it is time that we were putting into practice regulations that have long existed in other countries. We have failed to find any specific American city ordinances on this head, and the late road-law of the State of Michigan, simply providing that users of wide tires are entitled to a rebate of half their road tax, is a rare exception in State legislation of this character.

English road laws provide that where the load per wheel is from one-half to three-quarters of a ton, the width of tire shall not be less than 3 in.; where the load ranges from three-quarters to one ton, minimum width shall be four inches, and from one ton to one and one-half ton per wheel, the tire must be at least 6 in. wide. Vehicles with springs may reduce this tire width one inch. This law practically coincides with German and French regulations on this subject. To meet this English law the Broad street omnibuses complained of sifould have had tires 5 in. wide instead of 2½ ins.

The effect of narrow tires, with a heavy load, upon modern street paving has not yet been carefully studied, and reported upon. But it needs no special study to convince an observer that present practice imposes heavier duty upon such pavement than is necessary, in the face of possible

municipal legislation. In the case of stone blocks a broad tire may distribute the imposed load over the base of two blocks instead of one, and in the case of an asphalt pavement ruts are much less likely to occur than with the narrow wheel.

But as the change of wheels would be a costly operation in the aggregate, the salient question is how can this be done with the least damage to individuals. There is no doubt that a compulsory law could be framed and, if need be, enforced. But the better plan would probable be to directly tax the user of narrow tires under heavy loads, and to free from all tax the men who conform to established regulations. Such an arrangement would give time for the change and yet contain an inducement for as rapid a change as possible. This is practically the same principle that now induces the owners of certain newly built country roads to remit tolls on such vehicles as conform to published tire requirements. Broad tires are certainly better for use on soft or yielding roads; and on paved or well built macadam roads the tractive force is independent of the width of tire, provided this width exceeds 3 or 4 ins. To the objection that English wheels are clumsy and we will not have them, it, can be answered that if broad tires are made the law, wagon builders will soon eliminate the clumsy features. In the majority of our cities, the same street conditions exist that caused the marked failure in Philadelphia; and in such cases, at least, it is conclusively proved that some law of this kind is necessary and that its enforcement would be economical to the community. It seems a bit unwise to adopt modern street paving methods, and yet to refuse to use every reasonable precaution for the better preservation of these costly pavements.

THE PEARY EXPEDITION IN GREENLAND.

Our readers, among whom he has many friends, will be pleased to learn of the safe return to St. Johns, Newfoundland, of Mr. Robert E. Peary, C. E., U. S. N., from his exploration of the north of Greenland. Mr. Peary has sent a letter to the New York "Sun," from St. Johns, under date of Sept. 11, and we give it in full, as follows:

The North Greenland expedition of 1891-92 has returned its personnel, with one exception, safe and well. Two days after the "Kite" left last year, Red Cliff House was sufficiently completed to afford a somewhat better protection than the tent from the constant rains and heavy winds which prevailed for 10 days following her departure, and I was moved into it and stowed on a pile of boxes in one corner. Two weeks later, the house being completed externally, I sent Gibson in the "Faith," with Dr. Cook, Astrup, and Verhoeff to Northumberland and Hakluyt Islands to bring back a native hunter and family, and a supply of birds from the great loomeries on these islands. The party returned in six days after a successful trip, bringing a large number of birds, and my hunter, Ikwa, with his wife, Mane, two children, dogs, tupic, sledge and kayak, or boat. Work then commenced on the outer stone and turf wall which was to inclose Red Cliff House, and protect it from the cold and storms of the long arctic night. On the 1st of September the entire party went to the head of McCormick Bay to start the Humboldt Glacier depot. The party, Astrup, Gibson and Verhoeff, left on Sept. 7, and returned four days later, baffled by bad weather and deep snow. Astrup and Gibson started again on Sept. 22, and returned seven days later, having penetrated an estimated distance of 30 miles toward Humboldt Glacier. During the absence of these parties I made several boat trips to different places for deer, and then attempted to explore Inglefield Gulf, accompanied by Mrs. Peary, Dr. Cook, Matt Henson, and my native hunter. I was stopped by young ice, and nearly lost my boat in an attack from a herd of angry walrus, seven of which we killed.

On Oct. 1 the young ice stopped all further boat work, and two weeks later sledge trips were inaugurated. By this time I had discarded crutches, and could hobble about with a cane. The beginning of the long night found us with 31 reindeer, several seals and walrus, and several hundred birds in our larder, and a warm, snug house to shelter us.

More natives came and settled near us, and the winter passed rapidly in the preparation of our deerskins, the making of our fur clothing, sledges, skies, and other equipment, and with visits of the natives from all parts of the coast. The return of the sun, in the middle of February, was marked by a furious storm, accompanied by torrents of rain and a temperature of over 40° F. During 48 hours the entire region was swept and washed almost bare of snow, and Red Cliff was nearly flooded.

The fine weather in March and April, though the temperature was between 40° and 50° below zero, found us all in good condition, and gave opportunities for ski and snowshoe practice and the completion of my inland ice equipment. In the middle of April, with Mrs. Peary and my native driver, on a sledge drawn by 13 dogs, I started on the tour of the islands and shores of Whale Sound and Inglefield Gulf. Seven days later I was back at Red Cliff, having traveled some 250 miles behind my wild wolves, visiting all the natives in the gulf, and discovering the Leidy, Heilprin, Tracy, Farquhar, Melville, Meehan, Sun, Brinton, Hart, Hubbard, Sharp and Dahlgren glaciers, Mounts Daly, Putnam and Adams, and the sculptured cliffs of Karnak.

Upon my return, Dr. Cook, Astrup, Gibson, 12 dogs, and all the male Eskimos at Red Cliff, began transporting the inland ice supplies and equipment to and upon the ice at the head of McCormick Bay. I joined them with Matt and 12 dogs on May 3, and, after interruptions and delays from storms and the steep grades of the outer portion of the inland ice, everything was brought to the rolling surface of the true ice cap at an elevation of some 4,000 ft., and the real start may be said to have commenced on May 15. At this time there were 4 of us and 16 dogs, Matt having been invalided home.

On May 24, on the edge of the great basin of the Humboldt Glacier, about 130 miles from McCormick Bay, Gibson and Dr. Cook, forming the supporting party, turned back with two dogs, and Astrup and myself with the remaining dogs went on. At midnight of May 31 we looked down into Petermann Fiord from the edge of its great glacier feeder basin. Eight days later we saw the land at the head of St. George's Fiord, and then for two weeks were baffled and harrassed by storms, fog, crevasses, and steep ice slopes, while trying to weather the feeder basins of the St. George's and Sherard Osborne glacier system, the Hatteras of the Northern ice sea.

On June 26 we were under the 82° parallel, when the land which I had been keeping in view to the northwest confronted me to the north and northeast and then to the east, deflecting me to the southeast. After marching four days to the southeast, the land still extending southeast and east, I made direct for it toward a large opening in the mountains visible over the nearer summits, and landed on July 1.

On July 4, after three days' travel overland, I reached the head of a great bay, latitude 81° 37 min., longitude 34°, opening out east and northeast. I named this Independence Bay, in honor of the day, and the great glacier flowing north into it, Academy Glacier. I reached the inland ice again on July 7, with footgear cut to pieces, and ourselves and dogs exhausted or dead. We were lame from the hard climbing, sharp stones and frequent falls we had met.

This land, red and brown in color, and almost entirely free of snow, is covered with glacial debris and sharp stones of all sizes. Flowers, insects, and musk oxen are abundant. We shot five musk oxen and a large number of birds. Traces of foxes, hares, ptarmigan and possibly wolves were seen. The surface of the bay was covered with winter's still unbroken ice, prisoning the icebergs from the great glacier.

On July 9 we started on the return, taking a course more inland. In seven days we were struggling through the soft snow and wrapped in the snow clouds of the great interior plateau over 8,000 ft. above the sea level. We remained in the clouds some fourteen days, when we descended from them east of the Humboldt Glacier. Then, with dogs and ourselves trained down to hardpan, we covered over thirty miles per day for seven days till our eyes were gladdened by the deep green, iceberg-dotted waters of McCormick Bay.

On the last day, as I came over the summit of the great ice dome, lying between the border of the true inland ice and the head of the bay, I saw moving figures a mile or two ahead on the next ice dome. From that party burst almost instantly a cheer, and it was not long before I was clasping hands with Prof. Heilprin and his men, who were out on a reconnaissance preparatory to going in toward Humboldt Glacier to meet me.

A few hours later I climbed over the side of the Kite, anchored at the head of McCormick Bay, and the 1,300-mile journey was at an end.

Two days later the Kite steamed down to Red Cliff. Eight days after this all the work was completed, and nearly everything was on board the "Kite."

Verhoeff, who had gone on a geological trip, failed to return, and, fearing something might have happened to him, immediate search was instituted. During this search, prosecuted for seven days and nights by all the members of my party and Prof. Heilprin's, the "Kite's" crew, and nine Eskimo, the latter excited to the utmost by the promise of a rifle and a box of ammunition to the first who saw Verhoeff, the entire country between the place where Verhoeff was last seen and the Eskimo settlement which was his destination was carefully searched. The men fired guns at regular and frequent intervals, and shouted continuously. A knife and handkerchief lost by a party of hunters nearly a year previous were found, also minerals left by Verhoeff, and he was finally tracked to the edge of one of the large glaciers, where all further trace was lost, and after quartering the glacier in every direction we were forced to the painful conclusion that he had perished in one of the countless crevasses, and the search was therefore reluctantly abandoned.

With the exception of this sad accident, the expedition has been throughout most fortunate, and has carried out almost to the letter the original programme. The convergence of the Greenland coasts above the seventy-seventh parallel, the deflection of the main divide to the northwest above the same parallel, the termination of the continental ice cap below Victoria Inlet, and the existence of large glaciers in all the great northern fiords are among the discoveries.

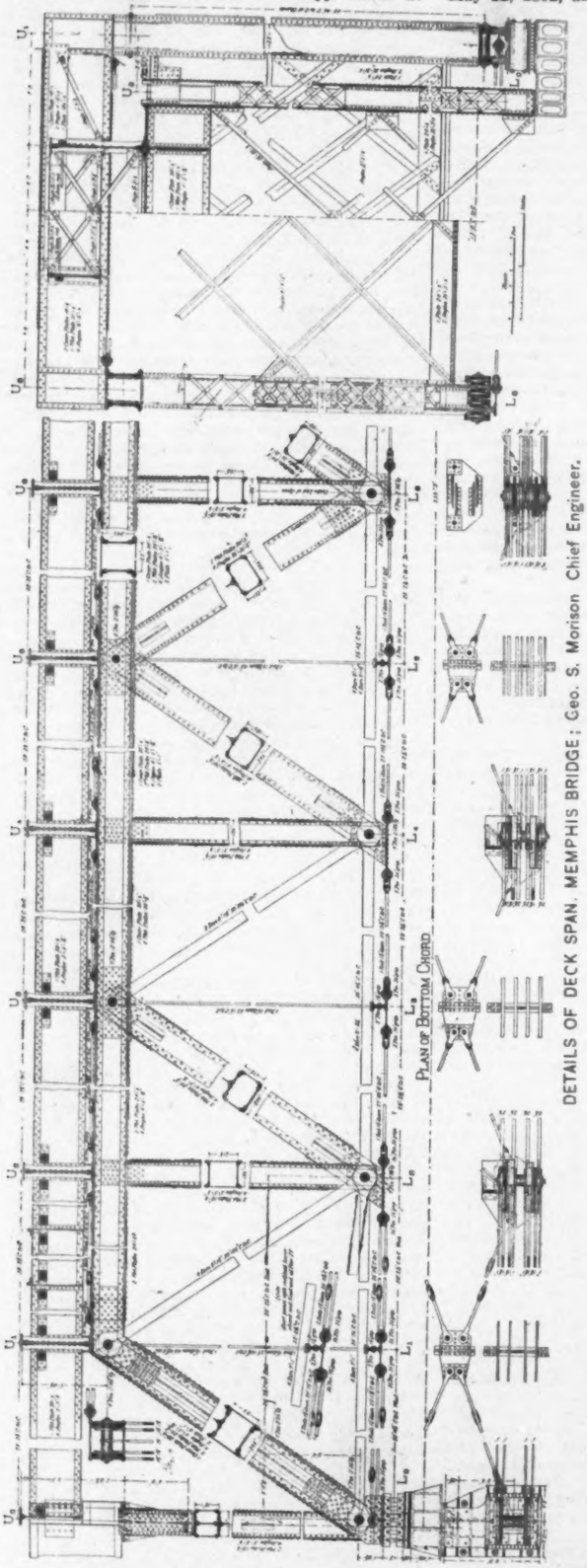
The expedition brings back much ethnological material, including tents, costumes, sledges, kayaks and dogs of the northern Eskimo, meteorological and tidal observations, and a large number of photographs of natives, dwellings, and costumes, and Arctic scenery.

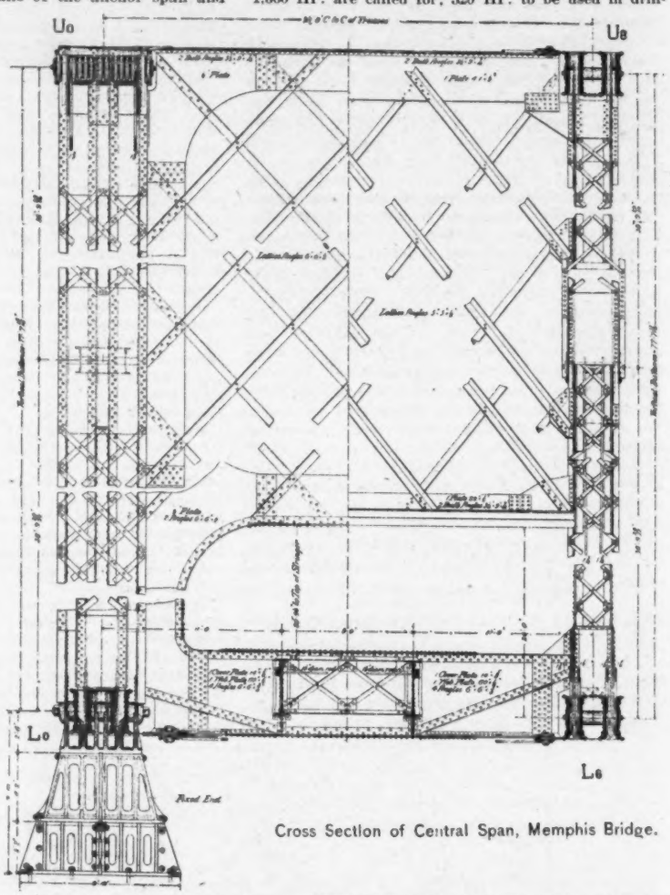
Baffin Bay
Davis Strait
Arctic Circle
Melville Bay
Smith Sound
Kane Basin
Kane Sea
Lancaster Sd.
Jones Sd.
Wolstenholme Sd.
Inglefield Gulf
Whale Sound
Independence Bay
Humboldt Glacier
Cape Alexander
Cape Isabella
Cape York
Cape Parry
Cape Sabine
Cape Melville
Cape Dudley Digges
Cape Hatherton
Cape Athol
Cape Shackleton
Cape Faraday
Cape Bowden
Cape Hawkins
Cape Alexandrina
Cape Clarence
Cape Mackenzie
Cape Mackintosh
Cape Mackellar
Cape Mackenzie
Cape Mackintosh
Cape Mackellar
Cape Mackenzie
Cape Mackintosh
Cape Mackellar

THE MEMPHIS BRIDGE.

(With inset.)

We show on our inset sheet and in the accompanying cuts full details of the central truss span, the suspended trusses, and the deck span of the Memphis Bridge across the Mississippi River at Memphis, Tenn., completed in the early part of this year. The relative positions of those spans are shown in the diagram of the bridge given herewith; E F being the center span, C D and G H the suspended trusses, and H I the deck span. The diagram also shows the general dimensions of the bridge. The drawings given herewith are in detail and need no further description. A complete description of the bridge was given in our issue of May 12, 1892, and details of the anchor span and cantilever arms in our issue of June 16, 1892. Engravings showing the progress of work were also given in our issue of Feb. 27 and March 12, 1892. Mr. Geo. S. Morrison, M. Am. Soc. C. E., to whom we are indebted for the illustrations shown, was Chief Engineer of the bridge. The iron work was done by the Union Bridge Co., of New York, and A. & P. Roberts, of Philadelphia, Pa.





Cross Section of Central Span, Memphis Bridge.

The new Massachusetts State Highway Commission has commenced work. At a late meeting of the commission it was decided to hold a series of meetings in the different counties, as far as these can be arranged for. Considerable statistics have already been gathered, and a beginning has been made in accurate surveys of existing main roads. The notes already made, by photographs and otherwise, show an even worse condition of affairs than was expected on some of the roads leading out of Boston. This survey work is thus far under the charge of Mr. Charles L. Weeks, a graduate of the scientific department of Dartmouth College, who has made a specialty of road engineering. State roads are suggested as a remedy to existing evils, combined with better regulated county roads.

"The longest tunnel in the world," says the "Journal des Mines," will be the Simplon, now practically only started. The plans call for a length of 12.43 miles, with the northern half on a grade of 1½ per 1,000, and the southern on an inclination of 6½ per 1,000. The workshops on the Rhone will cost $800,000, and 1,500 HP. are called for; 520 HP. to be used in drilling, 780 HP. in ventilating and 300 HP. in electric lighting. The power will be hydraulic, obtained from the Marsa River. The estimated cost of the finished tunnel is $1,240,000 per mile. Compared with other long railway tunnels the Simplon, according to present plans, would stand as follows:

		Length.
——	Simplon	12.43 miles.
1881,	St. Gothard	9.26 "
1871,	Mt. Cenis	7.65 "
1883,	Arlberg	6.38 "
1874,	Hoosac	4.62 "

But the new Croton aqueduct tunnel in New York is about 30 miles long, and the Schemitz drainage tunnel, in Hungary, is 10.27 miles long.

A newspaper nickel-in-the-slot machine is owned by the Automatic Machine Co., of Alliance, O. As described, the machine will serve you a paper and return the necessary change on dropping a nickel in the slot. It has been on exhibition for several weeks in Alliance.

A subscriber asks how many square yards of brick paving an average man can lay in a day of 10 hours. Trautwine says an average workman, with a laborer to supply him with bricks and gravel, will in 10 hours lay 2,000 bricks, or 53 sq. yds. flat. This seems about fair work when compared with 1,500 bricks per day laid in a common wall and 1,000 to 1,200 per day laid in outer surface of back walls, or 800 to 1,000 in ordinary street fronts.

A permanent exhibition of American Manufactures is to be opened in Cape Town, South Africa, under the patronage of Hon. D. P. deV. Graaf, Mayor of Cape Town; Hon. L. G. P. Kruger, President of the Transvaal, and Hon. F. W. Reitz, President Orange Free State. Capt. G. F. Hollis, U. S. Consul at Cape Town, is the Chairman of the local committee; and the New York office is at 140 Pearl St.

Two serious accidents to steam engines occurred recently. At Waco, Tex., Sept. 7, a 16-ft. fly wheel at the electric railway power station burst and completely wrecked the building. At Chester, Pa., Sept. 8, a 255-HP. Corliss engine was wrecked by the break-

age of the crank shaft. The mill was run partly by water and partly by steam power, and the whole load was thrown on the engine while the turbine was under repair.

The ocean-going whaleback steamer "Chas. W. Wetmore" was wrecked near Coos Bay, Ore., on Sept. 8. She ran ashore during a thick fog, so it appears that her loss was not caused in any respect by her peculiar construction.

Three sewer cleaners were killed by poisonous gas in a Jersey City sewer, on Sept. 12. One man was overcome by the gas as soon as he descended into the sewer, and two others lost their lives in vain attempts to rescue him.

The West Shore accident reported last week was found to have been caused by a loose wheel on the front truck of the locomotive. The five Italians who were supposed to have been drowned when the engine went into the river, are reported all right, which reduces the total fatalities to two.

A report on the sewerage system for Woonsocket, R. I., has been made by a committee from the City Council and Board of Aldermen. This report includes special reports by Engineers Charles A. Allen, Worcester, Mass.; Shedd & Sarle, Worcester, Mass., with J. Herbert Shedd, Providence, R. I., as Consulting Engineer for the firm; Rudolph Hering, New York; and John W. Ellis, Woonsocket. Mr. Allen Hazen, Lawrence, Mass., also reported on the quality of soil from proposed filtration areas. After Mr. Allen and the firm of Shedd & Sarle had made their reports, they joined in a supplementary report recommending the separate system with the admission to the sewers of water from about 6,000 ft. per acre, and intermittent

OUTLINE ELEVATION OF MEMPHIS BRIDGE.

downward filtration for purification, with lime for precipitation if the sewage proves to be acid, and with chemical precipitation as an auxiliary when the land becomes overtaxed, as between tunnels and beneath hills and streams, recommended by Mr. Allen, and siphons beneath streams, favored by Shedd & Sarle. Mr. Hering approved of siphons as giving better grades and alinements. On the other hand, Mr. Hering approved of pumping the sewage of the Social district as recommended by Mr. Allen. Mr. Ellis approved the supplementary report, and also Mr. Hering's recommendations, adding some valuable information concerning grades. The cost of the system was estimated at $456,605 in the original report of Mr. Allen, and at $587,140 in the original report of Shedd & Sarle. The Sewerage Committee recommended the adoption of a system as recommended in the joint supplementary report, and by Mr. Hering, as outlined above.

The failure of the wooden water-works tanks, at Nappanee, Ind., noted in our issue of Sept. 1, 1892, is attributed by Mr. George Arnold, President Board of Trustees, to the use of insufficiently strong iron bands, or hoops, and the tightening of the hoops before the wood had swelled, after the tank, which was new, had been filled. The tank was of "3-in. pine," 24 ft. in diameter, 20 ft. high, and was placed on tower 70 ft. high. The tank leaked badly, and the contractor, Mr. James Madden, Fort Wayne, Ind., tightened the hoops, after which the tank burst.

A 50,000-c. p. electric search light is to be placed on the Statue of Liberty, in New York harbor, at a cost of $4,000. It will be built and erected by the Schuyler Electric Co., of Middletown, Conn., which furnished the powerful light lately put up on Mt. Washington, and also has the contract for 30 less powerful search lights which are to be used on the U. S. cruisers.

A New York Central locomotive, lately remodeled, has driving-wheels 7 ft. 3 ins. in diameter and a total weight of 120,000 lbs., with two-thirds of this weight on the four driving-wheels. this locomotive is to be used with the Empire State Express.

A fifth satellite of Jupiter was discovered by Prof. E. E. Barnard at the Lick Observatory on Sept. 12. The satellite is of the 13th magnitude and is distant 112,400 miles from the planet. Its period is 17 h. 36 min.

Tarred mail-bags, for Turkish mail matter from the United States, are ordered by Postmaster General John Wanamaker, in response to a request by the Turkish Government.

The first U. S. 13-in breech-loading rifle is on the lathe in the shops in the Washington Navy Yard. When finished it will weigh 135,000 lbs., or 60½ tons. The gun is 40 ft. long, with a maximum diameter of 49 ins. It will throw a projectile weighing 1,100 lbs. with a muzzle velocity of 2,100 ft. per second, and a muzzle energy of 33,627 ft. tons. This projectile would penetrate 23.4 ins. of steel placed 4,500 ft. from the gun.

Road tests of 50-car trains equipped with the New York and the Westinghouse air brakes were made on the New York Central & Hudson River R. R. near Albany, on Sept. 9. The tests were conducted under the direction of Mr. P. H. Dudley, Mechanical Engineer of the New York Central company; and his official report of the results obtained will be awaited with interest.

PERSONALS.

Mr. E. S. Nettleton, late State Engineer of Colorado, is aboard the "Wyoming," from Hamburg, still quarantined in the Lower Bay, in New York harbor.

Col. E. C. Smeed, whose death was noticed in our last issue, was also professionally engaged in the construction of the Panama Railway, opened in 1855, under Messrs. Trautwine and Totten.

Gen. Jos. R. Anderson, one of the principal owners of the Tredegar Iron Works, at Richmond, Va., and especially prominent in their management during the Civil War, died at the Isle of Shoals on Sept. 7.

Prof. L. G. Carpenter, of Engineering Department of the State Agricultural College of Colorado, returned this week from an extended visit and inspection of the canals, dams, reservoirs, etc., of central France, Algiers and Italy.

Mr. George Westinghouse, Jr., was re-elected President of the Westinghouse Air Brake Co. at the annual meeting at Wilmerding, Sept. 6. All the old officers were re-elected with him. The report of Mr. John Colwell, Treasurer, showed a very favorable condition of affairs and a steady increase of business.

Rear-Admiral John Cumming Howell, U. S. N., died at Folkestone, England, on Sept. 11. He had been in the Navy since 1836 and from 1874 to 1878 was Chief of the Bureau of Yards and Docks. He was placed on the retired list in 1881. He is best known outside of naval circles as the inventor of the Howell torpedo.

Mr. W. M. Grafton, Signal Engineer of the Pennsylvania lines west of Pittsburg, has been appointed Consulting Engineer for the railway signal service inside the grounds of the World's Columbian Exposition at a salary of $8,000 a year, to be paid by the company taking the contract for the work.

Mr. Howard Holmes has been appointed Chief Engineer of the San Francisco Harbor Commission to succeed Mr. Marsden Manson, resigned, the appointment to take effect Oct. 1. Mr. Holmes was Assistant Chief Engineer of the Harbor Commission from 1867 to 1883, and has been engaged in cable railway and other work since that time.

Gen. James R. Anderson, President of the Tredegar Iron Works, of Richmond, Va., died at the Isle of Shoals, on Sept. 7, aged 80 years. Gen. Anderson was a graduate of West Point, and entered the Confederate Service in 1861. But he soon after resigned, and was engaged throughout the Civil War in making cannon for the Confederate Army, at the above mentioned works.

Mr. Edward M. G. Eddy, Chief Commissioner of Railways for New South Wales, having been charged in the Legislative Assembly, by Mr. Wm. F. Schey, with maladministration of his office and direct fraud and wrong doing, a royal commission was appointed to investigate these charges. The Sydney "Morning Herald" publishes in full the decision of this commission, entering into all the detail of the charges made last March. The commission finds that, "(1) There is no truth in any of these charges affecting Mr. Eddy or any of the Railway Commission. (2) That no shadow of suspicion or doubt rests on the honor or integrity of Mr. Eddy, or on the honesty or purity of his actions in the management and administration of the railways of New South Wales."

NEW PUBLICATIONS.

REPORT OF THE RAILROAD COMMISSIONERS OF THE STATE OF NEW HAMPSHIRE, for the year 1891. 8vo, cloth, pp. 339.

A very considerable portion of the first part of this report is taken up with the discussion of automatic couplers of the vertical plane, or M. C. B. types. It is not unusual to see the subject of automatic freight car couplers discussed both with ignorance and misrepresentation by New England railway men, but it is seldom that a State Railroad Commission goes so far out of its way to show its lack of knowledge of what is going on in the railway world as does the New Hampshire commission. We quote the following as a fair sample of its report on the subject:

"State legislatures have gone as far as has been thought prudent in passing laws requiring the use of something less deadly than the old contrivance for uniting cars, and inventive skill has exerted itself to such an extent that thousands of couplers have been patented and put upon the market, and yet there is not to-day one that is known to so meet the requirements, that those whose opinions are entitled to any weight will unite in recommending it, or that trainmen will willingly see it adopted. Experience with so-called improved couplers has, as a rule, been fruitful only in disappointment, or at best, in demonstration that if a coupler which will stand the test of use has been invented, it has not been brought to the attention of railroad men as it should have been. When it is considered that freight cars are constantly passing from one road to another, and that a car may during its existence be used upon every road in the country, it is evident that uniformity in type, if not in detail, in safety appliances is essential, and some progress has been made toward such uniformity; but, if we assume as we must, that the experience of trainmen is entitled to more weight in deciding the question than the theories of master mechanics and car builders, in traveling toward a uniform type of automatic couplers, we have gone straight away from all else that is desirable; that even the type that has found most favor and is most generally in use is by no means the best; and that we shall soon be compelled to discard it and return to one more primitive and less pretentious, the old link and pin. . . . . As it is, we have in use 200,000 of these couplers which we must rid ourselves of before men employed in making up trains will be as safe as when we started."

We have often had occasion to comment upon the seeming inability to keep up with the advancement in railway improvements in general, and the use of automatic couplers in particular, for which New England has always been conspicuous, and shall not further discuss the silly screed against M. C. B. couplers of which the above excerpt is a part.

ANNUAL REPORTS.—The following reports have been received, the reports relating to water-works and the names given being those of superintendents unless otherwise stated.

Newburgh, N. Y., Wm. Chambers; Yonkers, N. Y., J. A. Lockwood; Nashville, Tenn., City Reports, J. A. Jowett, City Engineer; Chicago, Ill., Department Public Works, J. Frank Aldrich, Commissioner Public Works; Toronto, Ont., Wm. Hamilton; St. John, N. B., Public Works, 1890 and 1891, Gilbert Murdoch.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.—Report of the Seventh Annual Meeting, held at Chicago, Jan. 27-29, 1892. S. A. Bullard, Sec. and Treas., Springfield, Ill. 8vo. paper, pp. 134; 50 cts.

A list of the papers in this report was given in our issue of Feb. 13, 1892.

ELECTRIC LIGHT IN BUILDINGS.—General specifications of wiring for. By Robert A. Cummings, Assoc. M. Am. Soc. C. E., etc. Published by author, 67 State St., Columbus, O. 8vo. pamp., pp. 10. $0.25.

This is a convenient book of 81 general rules, under the above head, rather than a specification, as that term is usually accepted. These rules simply specify what shall and shall not be done, but do this concisely and plainly.

SOCIETY PROCEEDINGS.

BOSTON SOCIETY OF CIVIL ENGINEERS.—The next regular meeting will be held on Wednesday, Sept. 21, at 7:30 p. m., at Wesleyan Hall, Boston. A paper on "The Gradual Abolition of Highway Grade Crossings" will be read by Mr. A. W. Locke. The paper will be illustrated by lantern views.

COMING TECHNICAL MEETINGS.

ENGINEERS' CLUB OF PHILADELPHIA.
Sept. 17. 1122 Girard St. Secy., L. F. Rondinella.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Sept. 17. Secy., F. D. Jones, Helena.
WESTERN RAILWAY CLUB.
Sept. 20. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Sept. 20. Secy., E. N. Clark, Pittsburg, Pa.
ENGINEERS' CLUB OF ST. LOUIS.
Sept. 21. Secy., Arthur Thacher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Sept. 21. Secy., F. Collingwood, 127 East 23d St., New York
BOSTON SOCIETY OF CIVIL ENGINEERS.
Sept. 21. Secy., S. E. Tinkham, City Hall.
CENTRAL RAILWAY CLUB OF BUFFALO.
Sept 28. Secy., Jas. Macbeth.
SWEDISH ENGINEERS' CLUB.
Oct. 1. Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
Oct. 1. Union Station, St. Paul.
ENGINEERS' AND AECHITECTS' CLUB OF LOUISVILLE.
Oct. 13. Secy., Edward Mead, Norton Building.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
Oct. 13. Secy., O. H. Landreth, Nashville, Tenn.
ROADMASTERS' ASSOCIATION OF AMERICA.
Oct. 18. Chattanooga, Tenn. Oct. 19. Atlanta, Ga. Secy., J. H. K. Burgwin, Grand Rapids, Mich.
AMERICAN STREET RAILWAY ASSOCIATION.
Oct. 19, 20, 21. Cleveland, O. Secy., Wm. J. Richardson Brooklyn, N. Y.
ASSOCIATION OF ENGINEERS OF VIRGINIA.
Oct. 21, 22, Roanoke, Va. Secy., J. R. Schick, Roanoke.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Nov. 17. At Atlanta, Ga. Secy., F. A. Charpiot, Macon.

ENGINEERING NEWS

AND

AMERICAN RAILWAY JOURNAL

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VOL. XXVIII. THURSDAY, SEPTEMBER 15, 1892.

D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST..... .....BUSINESS MANAGER

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ADVERTISING RATES. 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Monday afternoon; new advertisements Tuesday afternoon; transient advertisements, not later than Wednesday noon. The last pages go to press early on Thursday. We shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay

Our readers will learn with no common pleasure of Mr. Peary's safe return from Greenland, after having successfully accomplished the task which he had really set before himself, that of discovering and locating more of the unknown northern coast of Greenland, though he did not accomplish what many thought was his purpose "to reach the North Pole," or even reach a more northernly point than any man had reached before. The only visible reason why he did not do this latter, however, was that Greenland did not extend so far north on the previously unknown portions of its coast which Mr. Peary reached as it did on the parts which had been already explored. As will be seen from the map which we have sketched from Mr. Peary's notes in another column, he struck the coast well to the east of the prior limit of exploration on the west coast and far to the north of any previously discovered points on the east coast of Greenland. By so doing Mr. Peary has made a very substantial addition to our geographical knowledge, and he made it too at far less cost of money or life than heretofore, demonstrating the correctness of his theory that the smooth wastes of snow in the interior, and not the waterways or broken coast line, furnished the best means of reaching the northernmost limits of Greenland, which might, perchance, reach to the pole itself. It is even still remotely possible that they do so, for Mr. Peary left a gap of 100 miles at least where he only knows that his movements to the northward were impeded by mountainous ground. Whether these mountains are a mere fringe along the sea or whether they jut out toward the pole for hundreds of miles is still not absolutely certain, but any circumpolar map will show at once that the probabilities are all against Greenland proper extending at any point above 83° N., and in favor of Cape Robert Lincoln and "Lockwood Island," being parts of separate and much smaller islands than Greenland. The dominating characteristic of this entire region in all longitudes is a multitudinous fringe of small islands toward the North.

In respect of opening the way to further explorations at a small cost of life or money, as well as in his important new discoveries, Mr. Peary has earned for himself a high place among Arctic explorers. When he explained in his public address before starting his theory of traveling with comparative speed and safety on the smooth interior surface and of burrowing beneath the snow to guard against the only great obstacle which he admitted, the terrible Arctic gales and snow storms at temperatures far below zero, he was doubtless listened to with some incredulity. The sad fate of many prior expeditions which had set out with equal confidence in some theory only to have it confuted could not but be present in the mind. But Mr. Peary actually did just what he set out to do, met its hardships as he had expected to meet them, and found them no worse than he had expected to find them, as will be seen by referring to our issues of March 4, April 18 and June 13, 1891, where his plans are described.

He expected to journey some 1,320 miles in 66 days, or 20 miles per day. He actually journeyed some 1,350 miles in 80 days, 14 of which were lost in a series of terrible storms without progress ahead. His return journey was accomplished in some 28 days, in part at 30 miles per day. He felt confident that Greenland could not extend above 85° N., and has greatly strengthened the evidence that it does not extend much above 82° N. and is fringed by smaller islands at the north. The fact that he and his solitary companion traveled so far and so fast and returned "all well" on time makes his expedition absolutely unique in the annals of Arctic discovery, and when fairly considered, perhaps, its most brilliant achievement. That his brave wife should have borne him company in his winter quarters and even in some of his sledge journeys, and returned without serious hardship added a new element of interest to the expedition; and that even so untoward an accident as breaking a leg at the very beginning of his expedition should not have dampened his ardor nor cut short his achievements adds still more to the honor due to him. We may add that Mr. Peary is not a naval officer by training, as some have inferred from his assimilated rank of lieutenant, but a plain "civilian" civil engineer. The Navy seems to manage somehow to include "civilians" in its service without injurious and odious distinctions, and without knocking the bottom out of discipline; but the Army refuses even to contemplate such a possibility, with some honorable exceptions, and throws all its influence against it.

That ordinary vitrified sewer pipe has an ultimate strength to withstand an internal pressure of 100 lbs. per sq. in. is a statement which will, perhaps, surprise many engineers. Prof. M. A. Howe, in a paper in another column, reports experiments showing this to be the case, but proving that the weak point of such pipe, so far as bursting pressure is concerned, is the joints. The ordinary joint fails at about one-fourth the pressure which the pipe itself will withstand; but by using improved joints the author believes that their strength may be made equal to that of the pipe.

These facts are especially important in view of the use of vitrified pipe for water-supply conduits. In nearly every one of the few cases where vitrified pipe has been so used, great pains has been taken to keep the pipe on the hydraulic grade line so that it should not be subject to internal pressure. The detours which this makes necessary, however, may often do much to neutralize the saving over cast-iron or steel conduits. If vitrified pipe can be safely used under moderate pressure, its cheapness, cleanliness and freedom from corrosion and incrustation ought to bring it into extended use for water-works conduits.

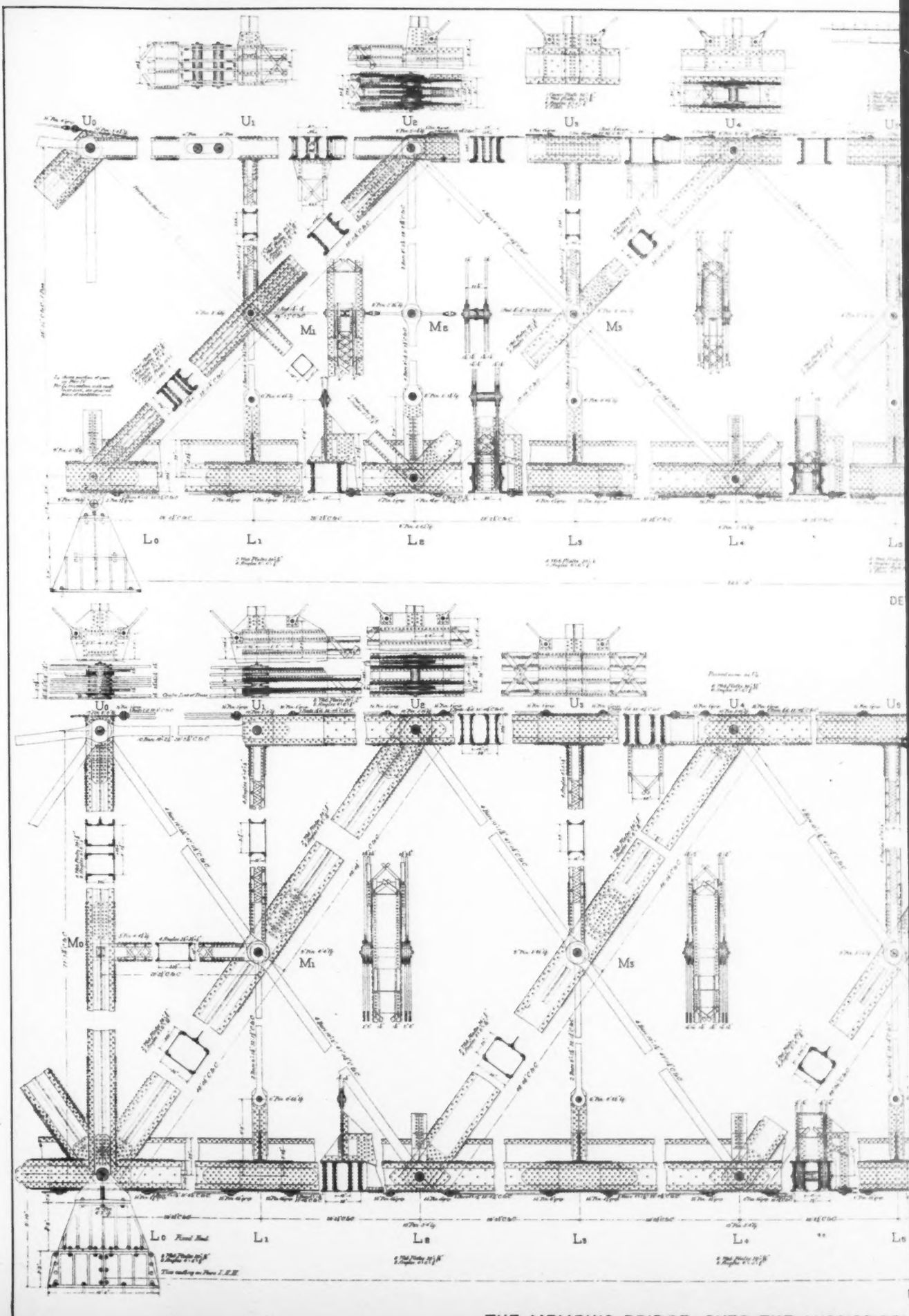
Of course it is to be remembered in using such pipe under pressure that while its strength is considerable, its resilience is very small. Hence it should never be used where a water hammer can come upon it. A steady pressure it can bear with safety, but any gates on the conduit except at the head should be considered out of the question. Bearing this in mind and taking proper precautions whenever the water is drawn off from or let into the pipe, it ought to be possible to use conduits of vitrified pipe under considerable pressure.

The saving in cost over cast-iron pipe in the case of the vitrified pipe main, 5.63 miles long, supplying Little Falls, N. Y., was over one-half, according to the paper by Mr. Stephen H. Babcock read before the American Water-Works Association in 1888 (Eng. News, April 28, 1888). Mr. Babcock, in the vitrified pipe mains laid under his direction, has taken great pains not to subject the pipe to internal pressure, and has used cast-iron pipe whenever it was necessary to drop below the hydraulic grade line. In the discussion on Mr. Babcock's paper, however, Mr. J. T. Fanning said that a 2 ft. vitrified pipe conduit 7,000 ft. long was in use under an average head of 15 ft. on the water-works of an Eastern city. The pipe forms the supply main leading from an impounding reservoir toward the city, and is connected at its lower end with an iron pipe. To prevent any water hammer coming on the vitrified pipe an open-topped standpipe was placed on its lower end, with its top 3 ft. higher than the water in the reservoir. The joints of this conduit were covered with wrought-iron sleeves packed with Portland cement. This conduit has been in use for 20 years and has given perfect satisfaction.

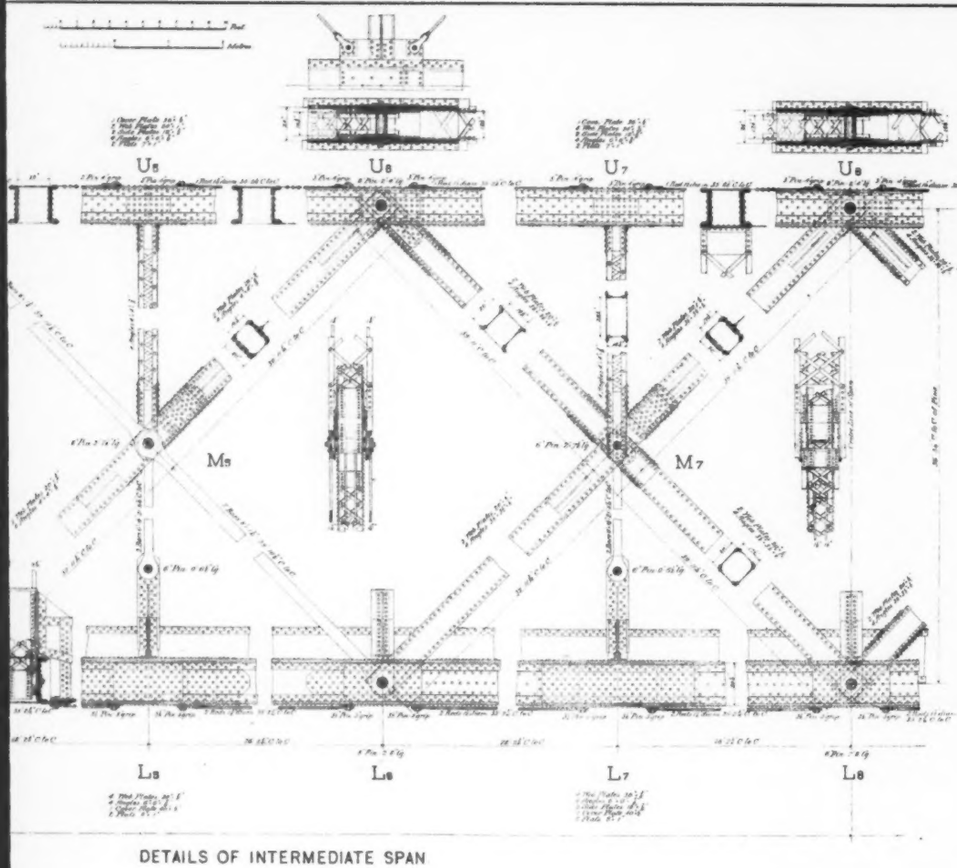
In our issue of Aug. 25 we illustrated and described a simple form of bucket fire extinguisher that is really worth more than a passing notice. It is of English origin, and we lately saw it in actual use in an English country house. One of these water-tight receptacles was placed on each floor of the house, concealed in a decorated box, which was itself the pedestal for a bust or a stand for plants. The air-tight cover is never fastened, but to keep the water within from being used for other purposes than the extinguishing of fire, the master of the house had each lid sealed with strips of paper sealed with a signet ring. The water did not evaporate, was always ready for instant use, and a disinfectant prevented it from becoming offensive. Actual trial with a tank in one of the outbuildings proved that it was most readily handled and always ready. No one need be told that ten well-filled buckets of water at the outbreak of a fire are worth a deluge after the fire has had time to gain headway, and this appliance is so simple and effective for the purpose intended that the device is well worthy of a more extended application. We do not believe that the principle is patentable, though its special details may be so secured. But whether patentable or not, it would seem that no better or cheaper plan could be suggested for the protection of private houses in town or country, offices or depositories of valuable materials and papers.

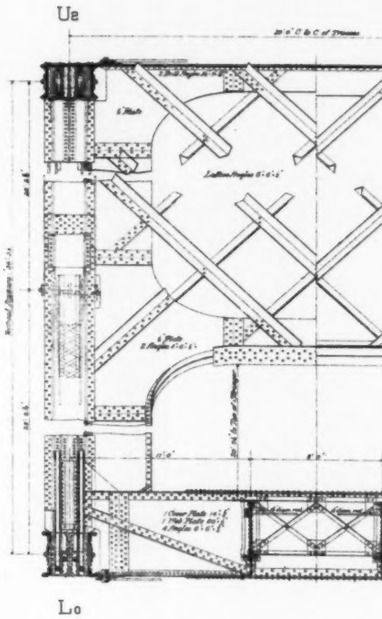
Should the cholera scare result in a temporary cessation of immigration followed by stringent permanent restrictions upon it, as it seems more than likely that it will, it may well prove a blessing in disguise even if some good lives are lost by it. The bringing over in a few days for a few dollars degraded classes of immigrants packed away in the hold like human cattle, has gone quite too far. It is a menace to the moral and political, as well as to the physical health of the people, and now that circumstances have compelled a temporary cessation of it, should never be permitted to be resumed. It is more than likely that the circumstances which compelled the suspension will compel its continuance for another year at least. During that period we may be tolerably sure that there will be a sudden increase in the "second cabin" passenger lists, but if second cabin decency and cleanliness are only enforced, that is as it should be, occasional worthy and desirable immigrants may be excluded by the necessity of paying $50 per second cabin passage, or even of making himself clean enough to be accepted in the second cabin, in the main no really desirable immigrant will be excluded and few undesirable ones will be admitted. The change for the worse in the quality of immigration is due only to one error: that the voyage is now cheap and short, instead of long and dear. Therefore the law of selection of the fittest is no longer acting in our favor. Anyone not an absolute pauper can pay his way over, and even the pauper can get his way paid over by the poor-house authorities as the cheapest way of getting rid of him. The money test of ability to pay a $50 passage may be a wide way of separating the immigrant sheep from the goats, but after all is it not a good one? Is there any other conceivable line which can be drawn between the good and bad classes of emigrants which is more likely to divide them fairly than that between those who can and those who cannot get together $50 to pay their passage over in some way or other?

If not, then all that we shall need to do to virtually restrict immigration will be to systematize the change in regard to "second cabin" passage which seems quite certain to take place during the next twelve months; to forbid absolutely the coming of emigrants to our shores except with a certain num-

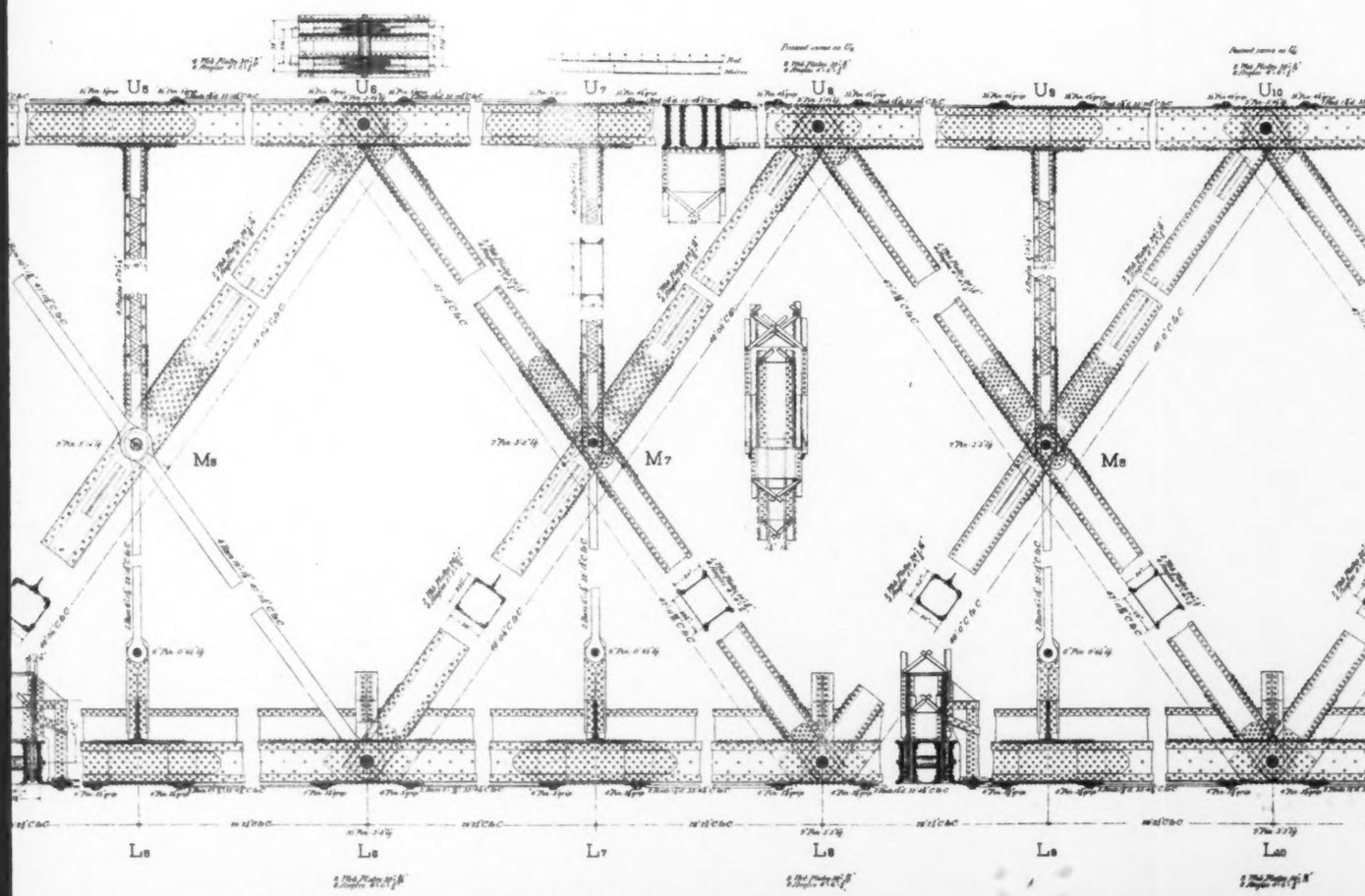


THE MEMPHIS BRIDGE, OVER THE MISSISSIPPI



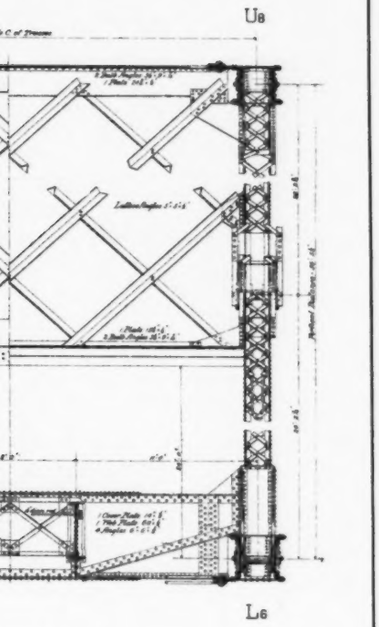


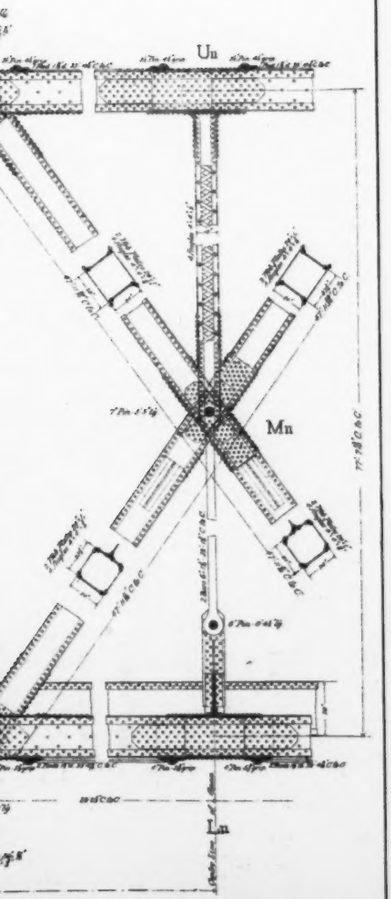
DETAILS OF INTERMEDIATE SPAN



DETAILS OF CENTRAL SPAN

ISSISSIPPI RIVER AT MEMPHIS, TENNESSEE. George S. Morison, Chief Engineer.





CHAS. HART & SONS, LITH, 98 VESEY ST., N. Y.

ber of cubic feet of saloon space and room space to each passenger, a certain number of square feet of deck space, a certain quality of food supply, etc., etc., all so graduated as to make the cost of the service something like $40 or $50 at least, and make it worth the money. On hygienic grounds alone the public is justified in demanding this; but its effect could not be good in every way, nor do we believe that after a time it would very greatly decrease the number of immigrants; it would only raise their grade. We have long believed that this was the best possible way of regulating immigration. We cannot but regard it as fortunate that circumstances have compelled a first step in that direction.

If the President's proclamation in the form of a marine hospital circular be taken literally, not even this first step has been taken, for it expressly excepts all vessels "afloat at this date" and as all the shipping of the world except what was on the stocks or in the dry-dock was then "afloat," the new rule would literally apply to none. But the plain meaning of the words was to except only vessels then at sea, bound for our ports, and so it will doubtless be interpreted. As a measure of protection against cholera it will be ineffective without a stringent oversight of all classes of passengers and freight. With all Russia pervaded by the virus as no European country ever was before, it will be a triumph of watchfulness and skill if both Western Europe and America do not suffer severely this year or next. But however it may seem at the moment, the current of degraded immigration to our shores was a more threatening danger than the cholera itself.

The great feat performed by the fast mare Nancy Hanks in lowering twice during last month the world's mile trotting record is especially worthy of notice here since her fastest time seems to have been due in a considerable degree to the kite-shaped track and also, it is claimed, to the use of ball-bearings and pneumatic tires on her sulky. In the table published in our issue of June 9 of mile records of the world, the best trotting record was that of Sunol, 2:08¼, made at Stockton, Cal., Oct. 20, 1891, on a kite-shaped track. On Oct. 17, at Washington Park, Chicago, on a "regulation" track the new "Queen of the Turf," as the newspapers say, lowered this to 2:07¼ and on Aug. 31, on the Independence, Ia., kite-shaped track she trotted a mile in the remarkable time of 2:05¼.

That ball-bearings and pneumatic tires will be the thing henceforth for trotting sulkies is evident, but we believe these were used in both of Nancy Hanks' recent feats, so that the difference of 2 seconds in her time would seem to be due to the advantage of the kite-shaped track only. What the next step will be to reduce the friction of the load carried by the fast trotter remains to be seen. The use of a one-wheeled sulky might possibly be made feasible, but if so it would probably be ruled out. It would be interesting to know what the friction of the present sulky is. Apparently it must be very small, less even than the air resistance; and the attachment of a "sharp prow" to diminish the latter would hardly meet with favor. We may be sure, however, that some improvement will be found to reduce the drag on record breaking trotters, if the driver has to carry a bottle of Frank R. Stockton's "negative gravity" in his pocket.

The bicycle record, which was given at 2:15 for the safety bicycle in the table referred to above, has also been lowered remarkably this summer, the latest being a mile in 2:06 4-5 made at Springfield, Mass., Sept. 9, on a regulation track.

As for the kite-shaped track, by which in effect one semicircular curve (and a little more) is substituted for two, a number of different records have seemed to indicate that it was about two seconds faster for the best class of trotters, and proportionately for slower animals. That it is somewhat faster is universally admitted. In order to eliminate this element of doubt, and perhaps to aid in reaching the desired goal of a mile in two minutes, which we seem to be fast approaching, there is a strong feeling among sporting men in favor of substituting some one specified "straight-away" track for these record-breaking races made against time. It is obvious that a good straight-away track must be the fastest track of all, and if it be found that the elimination of one semi-circular curve saves two seconds of time, the elimination of both of them should save another two seconds, and make the present record equivalent to 2:03¼ on such a track, which is near enough to 2:00 to make it extremely probable that such a limit will at last be reached, or even surpassed.

FUTURE DYNAMIC POSSIBILITIES.

Ordinarily it is of little advantage to those who find it more than enough to keep track of the present, as most men do, to pause to speculate much on the possibilities of the future. It is as foolish as for a traveler hurrying along some unknown road to be continually stopping to climb up on the fence in order to guess at his direction by peering a little way ahead. But from time to time in any journey, tending we know not where, it may be wise to lose considerable time to seek some elevation from which to get a long look ahead and back, and thus judge of our real progress and direction as we cannot judge from the immediate windings of the road.

In like manner we may find some profit, or at least some pleasure (such as we find in any other broad prospect) in leaving for the moment the beaten path of the present, and lifting ourselves far enough above it mentally to take a long look before and behind, in order to judge so far as may be whether our recent progress and attainments are really so great as they seem to be, or whether we have made a beginning in physical science; in other words just see whether we are fairly started on the road which may be said to be in sight, and open to man to travel over it if he will, or whether we are nearing the end of such part of this road as man with his limited powers may expect to travel.

If we thus look backward through the centuries to the dawn of history, there is no single fact in it which deserves to be regarded as more significant or surprising (outside of the alleged supernatural, of course) than the exceptional and utter inability of man to make any measurable progress in physical science, down almost to our own times; to days which many living men may almost remember. But two first-class or era-making inventions or discoveries were made in all this period, the wheel and fire. Perhaps we should mention also gunpowder and printing, but they are in a little different line. The wheel has not unreasonably been claimed to be the greatest of human inventions, in its far-reaching importance, of course, and not in its difficulty, for it was one of the simplest. The discovery of fire was probably accidental, and it was obtained until recently clumsily enough. Apart from these two, man's inventions consisted only of certain slow and clumsy processes of working over natural materials, as in weaving and metal and stone working.

Especially was this true in what we now know to be the vast realm of the utilization of dynamic energy, "converting the great sources of power in nature to the use and convenience of man." The first glimmering suspicion that there were any occult sources of such power did not dawn upon the race until men who were contemporaries of living men were born. Until then, for countless thousands of years only such sources of power as were immediately in evidence attracted man's attention, so far as any knowledge has come down to us. He saw that the ox had power, and harnessed it to a plow. He saw that a running stream had power, and stuck a paddle wheel into it to help him grind his corn. He saw that the wind had power, and made it move his ships and (at last) turn a wind mill. Of any thought that there might be anything beyond this we catch no glimpse, even in the keenest intellects of the successive ages, and even though man was frequently converting work into heat to light a fire, and sometimes (as in the little Hero of Alexandria steam engine) actually converting some heat into work.

When we consider what a surprising contrast this is to the growth of man's powers in other and (so far as we can judge) inherently more difficult directions the contrast is very remarkable. It has not attracted the attention which it deserves; partly, perhaps, because few writers of history are blessed with much knowledge of science or much interest in it. In many other evidences of mental power, in art, in poetry, in logic, in mathematics, in morals, in strategy, in ability to lead and govern men and organize a state, the ancient minds have never been surpassed, and a very long list of them have never since been equalled. And yet of all natural laws on which modern scientific progress rests, they all alike continued through countless ages as ignorant almost as their beasts of burden!

Even of the beauties of nature they had little appreciation, if we may judge from the fact that the great mediæval and early modern artists rarely painted a landscape at all, except as a background, and never decently well, or with any grasp of its beauties. To this day gardens laid out in a natural style of landscape art, to imitate natural beauty, are known on the Continent as "English gardens." Almost the first of these was created at Munich by an American, Count Rumford. Another, known by the same name, was created by Marie Antoinette as a great novelty as the Little Trianon. Previously to these the Continental love of nature was shown only by attempts to twist and distort her into geometrical forms, of which the gardens at Versailles are the greatest, of thousands of examples.

It is impossible not to feel that these two simultaneous phenomena were merely two diverse evidences of an awakening from an incuriosity as to nature which was practically absolute; which was but little removed from that of the beast. Man had, and has long had, the intellectual powers; he has shown that in other ways. He simply lacked the impulse.

This fundamental fact cannot be too strongly insisted on, nor too keenly appreciated, if we would truthfully judge of our present status and probable industrial future. However pleasing to man's vanity it may be to believe himself made in the image of the Maker of Heaven and Earth, and however fondly he may cherish that belief on other grounds, if he has the slightest shadow of intellectual honesty about him he must confess that, his knowledge of the useful laws of nature up to a hundred years ago was very slight indeed.

Until a hundred years ago at least, if he was in that respect made in the image of his Maker at all, he was a decidedly microscopic image, and seemed much more nearly to be made in the image of a cow,—which placid animal can combine the appearance and conceit of wisdom with real ignorance as perfectly as man himself!

But just about a hundred years ago—only a little more,—a great change began which surely was the most momentous in the material history of mankind. In many different minds of many different countries there began to be evident all at once the working of some new leaven on the inert mass. Man had grasped at last the fact that there were some things in nature which he might know but did not; that there were hidden as well as open sources of power which he might perhaps learn to control; that there were things in nature to love and to study as well as to fear. In many directions, and not simply in one, inquiry began almost simultaneously. About that time crude prophecies of the steam engine were invented; about that time electricity was discovered; about that time the first experiments on the nature of heat were made and the modern science of chemistry was founded; about that time abstract and physical mathematics took a new lease of life; and about that time an interest in the beauties as well as the mysteries of nature began to grow strong. The awakening even in these separate subjects was not the work of any one man. It was general. At least twenty men deserve to be honored and remembered for their original work in creating the steam engine. At least fifty men were simultaneously studying it with effect.

Well, out of all this travail, a child was born: several children in fact, but with one only are we concerned. The steam engine was upon us. In order to understand its real nature we have been compelled to take a kind of general view of all the ramifications of its ancestry. One pre-eminent name will always be associated with it, the name of Watt. His invention justly ranks as the most beneficent in human annals; in the realm of physical science. No one has since appeared who is even a good second or third or tenth as a benefactor of mankind. And what did Watt do? Should the remembrance of it make man proud or should it make him humble and ashamed?

He conceived the profound idea that if we were

injecting hot steam into a cylinder, and had to have it hot to do some work; and if we knew that steam rushed into that cylinder with inconceivable rapidity so soon as it had a chance, then it was not sensible to inject cold water between times, to cool off the steam and the cylinder too, but that we might just as well let the steam rush out again with the same rapidity and cool off somewhere else! That was the beginning and the end of all he did to raise him above his fellows and create his immortal fame as the greatest material benefactor whom mankind has ever known!

And it took us 6,000 years of history to train a single man to think a thought like that! And in a hundred years more of "wonderful progress" to our present "pinnacle of civilization," no single man among us has been able to take any era-making step beyond it! Was it work meet for an intellectual giant or an intellectual dwarf to think of such a thing? Were not his contemporaries weakling's mentally that they had to wait for his genius to think of it for them, when men like Smeaton, who are still famous, had far more working knowledge of the steam engine than he?

And what are we but the children of those contemporaries, with no whit greater mental powers? We have at least learned to realize our own ignorance, it is true, by discovering that we are surrounded by potential energy which we do not know how to utilize, and that is no small gain; but is it reasonable to suppose that those problems are really much more difficult which we can see but cannot solve. There are certain analogies, it is true, as with Shakespeare and other phenomenal men, which might lead us to fear that whether Watt's genius was absolutely great or little, it might represent man's high-water mark, which he might not soon or ever again reach. But this analogy is hardly sound, because Shakespeare and most other phenomenal men in other lines are honored for a lifetime of sustained greatness of mind or soul. Watt's pre-eminence came only from a single thought. Was it then so wonderful? Was it possibly the last great word of science; or was it but the fruit of man's first feeble efforts to conquer nature, destined to be greatly surpassed and outdone?

We may not be too positive in our answer, but all experience and all analogy teaches us that man's great rate of mental progress is very, very slow in any direction; that he never suddenly acquires great powers which were wholly lacking before, and hence that his first steps toward victory over nature must necessarily have been feeble and stumbling, like a child's in learning to walk. The simplicity of the idea by which we gained so much and by which such lasting fame was won, and the time which elapsed before it was thought of, is fully in consonance with this idea.

Nevertheless, it would not be wholly beyond an analogous experience should it prove that one man had by a single happy thought carried us so far ahead as to bring us at a bound near to the ultimate limit of man's powers as we know already in many lines. But what do we know about our status in utilization of sources of energy? We know positively from observation of animal life that the interconversion of chemical energy, heat, light, electricity and working energy is an exceedingly simple operation so far as bulk of mechanism is concerned. The human body seems to convert chemical energy into either heat or working energy, or both, at will. By some subtle thermostatic arrangement the production of heat is maintained automatically at just the right rate under all extremes of conditions. We can at will do either nervous (electrical?) work with the brain or physical work with the body, drawing the supply of energy from the same source, to all appearance. In some measure we can do both at once. In many animals electricity is produced with equal ease. In dozens of other species, light is thus produced, without measurable heat. This last light man can imitate in the laboratory to some extent by so-called "phosphorescent" substances, but though the secret of light without heat is thus right under his nose, man's only conception of a light for practical use is still to make something red-hot, which converts into light only a small percentage of the energy used.

We now know also with some accuracy where the steam engine really stands in the scale of perfection. Good ordinary coal contains 14,000 H.U. of heat energy (that we know about and know how to measure). The "mechanical equivalent" of heat is 772 ft.-lbs for each HP. (we still stick to the old value). Then $14{,}000 \times 772 = 10{,}808{,}000$ known foot-pounds of work in 1 lb. of coal; and $10{,}808{,}000 \div (33{,}000 \times 60) = 5.46$ HP. hours as the work which might be done by each pound of coal. The very best marine engines will sometimes get 0.7 HP. hours out of a pound of coal, or 1/8 as much as this; the average of all the engines in the world, not over 0.3 HP. hours, or 1-18 as much!

To utilize even this scanty fraction of our energy we must connect with our engine a bulky and treacherous apparatus for generating the working fluid, weighing ordinarily several times as much as the engine itself. This attachment is no part of the prime-mover, but only serves to transform our energy from a state in which we have not learned how to use it into one which we think we understand; a function strictly analogous to that of the country doctor's medicine which was to "throw the little feller into fits," because he (the doctor) was "death on fits." It is this bulky attachment, to our only serviceable heat engine, even more than its wastefulness which detracts from its usefulness. Besides greatly increasing the size and cost of the machine, it requires an always watchful expert to handle it, or it at once becomes an engine of destruction. Hence it can meet small or temporary supplies of power only at great disadvantage. Lately we have in part removed this latter difficulty by the invention of the electric dynamo and motor, but as we have no other means than the steam engine for power for the dynamo, all the other disadvantages of the steam engine apply also to electric prime movers.

When all these facts are kept in mind, have we more reason to regard the steam-engine as the product of a high degree or of a low degree of mechanical aptitude? To ask this question is to answer it, it seems to us. We are unable to believe that we are now in anything more than the early dawn of the potential scientific era. It may be that the luxury and wealth which even a little knowledge of nature's forces is given to us will so corrupt and enfeeble man's energies that ere long he will begin to retrograde morally and mentally, but we hope for better things. At any rate we should not delude ourselves with the notion that ours is such a "high civilization" that it requires an absolutely great ability or genius to create it or go far beyond it. On the contrary we have every reason to believe that means which even we will recognize as simple when we can look back upon them may ere long carry us as far beyond the steam-engine era as that is beyond the dark ages which preceded it.

Especially have we reason to infer from analogy and history that a light and simple heat-engine of high efficiency may yet be developed, lacking the elements of great bulk, cost and explosive energy, and so not requiring much expert attention. With such an engine, supplemented by our present knowledge of dynamic electricity, what a future might open to the world! In the first place, transportation even over our present railways and waterways would be enormously cheapened. Considering all direct and indirect effects its labor cost might be reduced one-half, and by the increase of traffic which would result, nearly another half of the remaining half. It could also be made much quicker. But such an engine would also make it much less expensive to build new railways, and thus our present railway system could be greatly extended.

Horses as sources of power could be almost wholly dispensed with; they would be needed only for pleasure driving. The only serious obstacle to the use of the steam-engine on highways, streets and farms has always been its bulk, weight, danger and necessity for expert attendance. Electricity even now promises to drive out the horse in time, though its lack of portability except by wire, and its dependence on the steam engine for energy, stand in the way. As horse-power is very expensive, and has only convenience and portability to recommend it, this alone would be an enormous gain to man. Streets and highways might be expected to be greatly improved to give a better surface for traction engines.

Especially would agriculture, which so far still depends wholly upon man and animal power for working energy, be quite transformed, and by becoming a more attractive occupation solve some serious social problems now pressing upon us. When the farmer can ride on a self-propelled vehicle and merely guide the plow or electric hoe or cultivator or rake, and when also his churning and pumping and feed-cutting and other farm work can be easily done by mechanical power, the farmer's need will be for intelligence, not brawn, and farming work will no longer be escaped from if possible. This and the other causes noted will tend to check the concentration of population into great cities, and to spread them far out into the country. On the other hand the isolation of farmers in order to be near to the work in hand would no longer be so necessary, so that farmers could concentrate into villages. These effects would co-operate to efface the present sharp distinction between city and country life. The advantages of each would in large measure be extended to both, and their disadvantages eliminated.

Finally, most important of all, household science for city and country alike would be transformed. The great problem of heating, lighting and ventilating houses would be solved; it could be done by electricity easily and well. The same is true of all cooking processes. Already electric toasters, coffee-pots, chafing dishes, pots and kettles for boiling water without fire, flat-irons, broilers, and it may be ovens, are on the market. If not now common they soon would be; the cost, infrequency and non-portability of electric power alone stand in the way of their universal use. The same is true of many little domestic machines for washing and ironing, washing dishes, sweeping, washing and dusting floors and walls, running elevators and other like household uses. Thus the smaller burdens of life, especially for women, would be made lighter.

Such are some of the possibilities which await the advent of the man who can think some thought, perhaps as simple as Watt's, which will give us a simple and efficient heat engine. Are we to wait forever for him as for a being of superhuman gifts, or may we believe that it requires only the right direction to very ordinary gifts, and hence is sure to come, and perhaps soon?

LETTERS TO THE ED

THE VAN ZILE TRACTION DEVICE.

Sir: In the article on my traction device, published in your issue of Sept. 8, you note as an important limitation in the application of the principle the fact that with one pair of wheels grades in only one direction can be mounted or descended.

Referring to Fig. 3, it will be seen that the truck ends of the arms bear against castings, the inner surfaces of which are concave, being arcs of circles, which have the same centers as the traction wheels. By means of a simple reversing device, not shown in the cut, the arms can be made to bear on any part of the castings, and thus make an angle with the perpendicular to rail on either side of center. If the arms are thrown to the opposite ends of the castings and the motor is reversed, grades in the opposite direction can be mounted or descended. This reversing device is simple and rapid in its action. Yours truly,

H. L. Van Zile.

Albany, N. Y., Sept. 9, 1892.

RELATIVE COST OF NARROW-GAGE RAILWAYS

Sir: Would you please give me the average difference in cost per mile in the construction of a standard or narrow gage railway? Yours truly,

C. W. S. Wilson.

New Rochelle, N. Y., Aug. 27, 1892.

(No narrow-gage railways of any importance have been built in this country for many years. The average difference of cost as the two were actually built may have been about as 100 to 65 or 70. The average difference in cost for a similar standard of construction, i. e., with equally heavy rails and ties for equally heavy rolling stock, running at equal speed, was and is practically nil. Something like 5% of theoretical difference may be computed, but practically this is not secured nor securable, because the difference in patterns increases cost more than enough to balance the theoretical saving, leaving the inconveniences of break of gage a net loss. Therefore the craze for narrow-gage railways has completely died out. It never had any sound excuse for existing.—Ed.)

GRAPHICAL VS. NUMERICAL COMPUTATION.

Sir: Inclosed I send you a sketch illustrating the two methods—analytical and graphic. It shows conclusively the close approximation of the graphic method to the

first named in getting the external forces or reactions; also the amount of labor saved. If you think it worthy of notice in your valuable paper I shall be happy in having sent it. Yours truly,

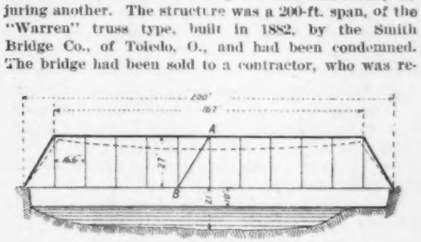
W. D. Skidmore.

Brooklyn, N. Y., Sept. 1, 1892.

(We think it worthy of notice but not of publication, as it is merely illustrative. Those familiar with graphic methods of computation need no illustration; those unfamiliar, can find plenty of illustrations and explanations if they will. It is to be feared that a considerable fraction of the profession will always continue to be better supplied with pencils than brains, and will not be happy unless they figure out their computations numerically, even when the data they are using are far less precise than the graphical methods of computing from them which they might use.—Ed.)

A HIGHWAY BRIDGE ACCIDENT.

Sir: On Aug. 1 a highway bridge across Pine Creek, at Rainsville, Ind., fell, killing one man and fatally injuring another. The structure was a 200-ft. span, of the "Warren" truss type, built in 1882, by the Smith Bridge Co., of Toledo, O., and had been condemned. The bridge had been sold to a contractor, who was removing it to make way for a new iron structure. The contractor, whose specialty is masonry, and not bridge work, had employed an "expert" to superintend the work of removal. The false work consisted of a pole truss under each panel-point, without longitudinal bracing. After removing the floor-beams and joists, the trusses were raised by jacks, and the diagonal braces removed from both trusses, leaving only the vertical ties and end braces to support the heavy wooden top chord, 168 ft. in length, having a sectional area of 288 sq. ins. Immediately before the accident there were no braces in one of the trusses, and the other had but one.



Highway Bridge, Rainsville, Ind.

The accompanying diagram shows roughly the situation of the East truss immediately before the fall. When the diagonal brace A B was removed, the upper chord settled, assuming gradually the position of the dotted line, and finally fell. I believe this is worthy of note, because it shows the probable result of intrusting such to men inexperienced in bridge building, or ignorant of bridge construction, as this "expert" very clearly was.

Yours,

W. P. C.

Williamsport, Ind., Aug. 20, 1892.

BALDWIN LOCOMOTIVES AND RAILWAY IMPROVEMENTS IN NEW SOUTH WALES.

Sir: The attack on American engines in Australia has completely failed, and the huge blue book giving the official account of the battle shows that the assailants had little ground to go on, and that the criticism was evidently directed against the engines because they were new and more powerful than the old engines, either English or American and therefore, doing better service on the heavy grades, and dispensing with double-headers. As another attack was made simultaneously by another politician (an ex-expressman in the railroad service), on the importation of some English engines which were alleged to be ordered at exclusive prices from "a ring," it would appear that the whole attack was really owing to the present management, by the Railway Commissioners, refusing to bow to political influence.

All the charges made by both politicians appear to have been most thoroughly investigated by two Royal Commissions, with the result that the personal charges against the railway management are declared to be wholly without foundation, while the Baldwin engines are found to be efficient and serviceable, when some defective tires and axles are replaced. As these defects appear to have been discovered and remedied by the railway authorities and the makers, quite independently of the investigation, the result must be very gratifying to Mr. Eddy, the Chief Commissioner of Railways, and his staff, one of whom, Mr. D. H. Neale, is well known to many readers of Engineering News. Mr. Neale appears to have advised that the engines should be ordered, and defended his action and the performance of the engines very vigorously during the four days occupied in his examination by the investigating commission.

The whole affair throws a light upon the practical disadvantages incident to the state ownership of railroads; for, even if placed under independent and non-political management of railway commissioners, that body must owe its existence to legislation passed, and, therefore, revocable by a political body. And it is evident that while disappointed politicians may not, in the face of public opinion, dare to wholly repeal an act, and openly revert to partisan management with its large field for political patronage, they can, under the cloak of privilege, harass the management by attacks, which, even if baseless, take time to disprove. In the neighboring Colony of Victoria, the first to place the railroads under non-political management, the act has been practically repealed, and the commissioners replaced by others of a more pliant disposition, willing to run the road in accordance with the ideas of the Minister in power. The position is still further complicated by the fact that in Australia all the State railways are built with money borrowed in Great Britain, and that if the net earnings fail to meet the interest on the loans, the deficiency has to be met from the general revenue of the colony. It is, therefore, not surprising that both Mr. Eddy, the Chief Commissioner, and Mr. D. H. Neale, in their evidence, laid especial stress on the economic benefits to be derived from the adoption of powerful American engines, capable of hauling a good paying train load.

Many improvements in grade and curves have been made recently in New South Wales in order to increase the train load. A loss of elevation on the Blue Mountains on a grade of 3%, with 11° reverse curves, has been reduced to a 1.4%-grade without any lost elevation. This deviation also shortens the longest length of 3%-grade. Many of the 11° curves have been reduced to 7°. One of the two switchbacks will be cut off shortly, saving about three-quarters of a mile distance and some lost elevation. A cut-off is also under survey to abolish the other switchback, as it is found that the switchbacks limit the length of train, it being impracticable to extend the foot of the Y. In order to guard against break-in-twos, all trains are worked up the 3.3%, and 3% grades with a pusher, and pusher trains have now to be divided on the switchback, entailing delay. The road has been quadrupled for 8 miles out of Sydney, on account of the heavy local suburban traffic, and an additional switching yard, on the gravity system, has been provided at the junction of the Western and Southern stems, 12 miles from Sydney. This will enable all freight and stock cars to be sorted and made up in trains direct for their different destinations in Sydney and suburbs, saving yard room and local switching in the city where land is valuable.

The electric staff system is now largely used on the single track roads in the colony, thus insuring only one train being between two stations at any time. Every runner before leaving a station must have an iron rod of peculiar shape given him before the train starts. This rod can only be extracted from a box in the operator's room, when all the rest of the corresponding staffs are at one or the other stations at the ends of the section. The principle is similar to that of the train tablet, but is found more convenient in practice, and is an absolute safeguard against rear collisions, which may occur under the ordinary staff system, though butting collisions are impossible.

C. V. R.

Sydney, New South Wales, Aug. 5, 1892.

THE STEARNS TRUSS FOR HIGHWAY BRIDGES.

Sir: I beg leave to inclose a print of a tracing which I received in 1881 from Mr. Frank A. Leers, at that time Chief Engineer of the Passaic Rolling Mill Co., Paterson, N. J. This tracing shows a design by Mr. Leers of a highway bridge of 198 ft. length, of the same type as proposed and patented by Mr. Stearns and published in Engineering News of July 21, 1892.

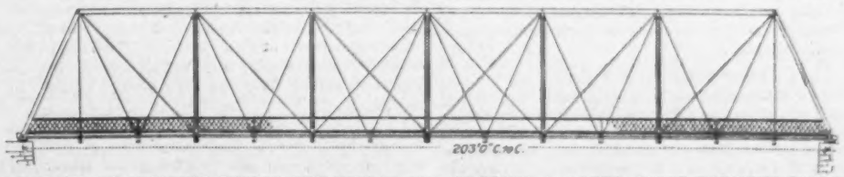
Mr. Leers at that time spoke to me about the considerable saving of material of such trusses, and as the system was novel and seemed to have some merit I have kept this tracing ever since.

I have no reason to doubt that Mr. Stearns designed this truss independently, but the credit of having originated the same certainly belongs to Mr. Leers.

Yours truly,

St. Louis, Aug. 1, 1892. Carl Gaylor.

(The accompanying blue print shows a complete design by the Passaic Rolling Mill Co. for a road bridge of 198 ft. clear span, 22 ft. 6 ins. wide in the clear, and dated Feb. 24, 1881. We reproduce the elevation only, omitting the strain sheet (which is for a moving load of 90 lbs. per sq. ft. or 2,025 lbs. per lin. ft., and a dead load of 1,075 lbs. per lin. ft.). We see no occasion for any one's competing very earnestly for the credit of first inventing this design. The idea is simple and obvious enough, and doubtless has been suggested in a more or less formal way by a number of engineers. For a purely static load it should be highly advantageous; for a highly "unstatic" load, like railway trains, it is quite unsuited. For ordinary highway service it should do very well for long spans, if properly designed, especially if a solid paved roadway is to be carried across the bridge. For short span bridges it is much less suitable, because of the greater tendency to vibration resulting from the long compression members and lighter weight.—Ed.)



ELEVATION OF HIGHWAY BRIDGE DESIGNED IN 1881 BY FRANK A. LEERS, CHIEF ENGINEER PASSAIC ROLLING MILL CO.

THE BARRETT BRIDGE FAILURE ON THE MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE RY.

Sir: Replying to your inquiries concerning the recent accident on our road, near Barrett Station, I give you the following facts:

Barrett is located on the lower Pomme de Terre lake, which covers 500 to 600 acres. The Pomme de Terre River flows through the lake, and is crossed by our line one-half mile below it, and about three-fourths of a mile east of the station.

On Aug. 24 and 25 there occurred in that locality a severe rainstorm, the heaviest reported since the settlement of the country. This poured torrents of water down from the rolling country adjacent to the valley, filling the lake till it broke through the dike at its lower end in several places and swelling the stream to an unusual volume.

The railway crosses the stream on a pile bridge of 18 bents, driven to 15-ft. centers, track about 18 ft. above bed of stream, which is composed of gravel. The piles were Norway pine; the superstructure of white pine timber, each span having eight stringers 6×14 ins. × 16 ft. The ties were pine 6×8 ins. × 12 ft., 14-in. centers, and the guard rails were 8×10 ins., bolted through ties and outer stringers. The bridge was built by contractors in the latter part of December, 1886, and had been inspected only the day previous to the accident. At ordinary low water this stream has a width of about 30 ft., and is 1½ ft. in depth; at the time of the disaster, 1:30 p. m., Aug. 26, 1892, it was 8 ft. deep in the channel, and extended the full width of the bridge between embankments, about 225 ft., being the height which it had maintained since early in the forenoon.

Between 6 o'clock a. m. and the time of the accident six trains passed over the bridge, which showed no signs of weakness. The last of these trains, the regular eastbound passenger, crossed the bridge only an hour before the break. At the meeting point the engineers of the two passenger trains changed runs, and so it occurred that the engineer of the wrecked train had crossed the bridge but an hour before. He reports that on his return he noticed a place in the channel, where for about the length of one bent, the track had gone a little out of line, and that he felt the engine lurch as he passed over that place.

The train, which was equipped with air brakes, and running at a speed of 30 miles an hour, consisted of the engine, baggage car, two passenger cars, and a palace stock car loaded with horses, the latter following the engine. The engine and this car passed over the bridge. The former did not leave the track; the latter had all wheels derailed except the leading pair of the front truck.

The broken superstructure showed marks of derailed wheels for over 150 ft. from the west end of bridge. The last seven bents were pushed forward in a slanting position; piles mostly broken off at or a little below ground line.

On this portion of the wrecked bridge stood the baggage car, its forward end supported by the front truck, which had been driven back toward the center of the car. Its rear platform rested on the front end of roof of forward passenger car, its rear truck being suspended by the chains and partly supported by the bridge

superstructure. The two passenger cars, still coupled together, stood upright in the stream on the wreck of the remaining portion of the bridge, the water running in at the windows.

These coaches were not more than a foot off the center line of the roadway, and the baggage car was only a little further out of line.

There were six persons killed, all of whom were on the platforms or standing in the doorways. Five of these were laborers, who had been hired by this company for work on its extensions. 10 persons, who are all expected to recover, were more or less seriously hurt, and 20 or 30 were slightly injured. The only one sustaining mortal injury was the company's roadmaster, Mr. John McMillan, who was sitting in the rear seat of the rear coach and as the car went down, was thrown violently forward, and suffered a spinal injury, which I regret to say, has since resulted in death. He was well and favorably known throughout the Northwest as a capable and faithful official. He had served this company since 1887, and prior to that time had for many year been in the employ of the C., M. & St. P. Ry. Co.

The conclusions are:

1. The high water had scoured the bottom sufficiently to cause a slight settlement at one end of one or two of the channel-bents, throwing track out of line. 2. The weight of the engine threw the track still more out of line, causing derailment of cars, which broke through the bridge and pulled it down in line with the moving train.

Yours truly,

W. N. Rich, Chief Engineer,
Minneapolis, St. Paul & Sault Ste. Marie Ry.
Minneapolis, Minn., Sept. 5, 1892.

((The coroner's jury, which reported on this accident, brought in a verdict from which we quote as follows:

After making diligent search and inquiry, we find that the wreck of the said passenger train was caused by the defective and rotten condition of said bridge; that at least three-fourths of the piling in the bridge was at or near the ground or water mark nearly or entirely rotten, and that none of the piling in said bridge was fit and proper to be used in a bridge of any kind; and that said bridge was and has been for a long time unsafe for a train of any kind to pass over. After having fully investigated the alleged washout we find that there was no washout whatever, and that the late storm had done no damage to said bridge that contributed to the cause of the wreck.

The jury also censured the general officers of the railway company and held them guilty of "gross and criminal negligence." It is stated that behind this verdict is the well-known hostility of the farmers to corporations. Barrett is a stronghold of the Farmers' Alliance; and as election is approaching interested parties are ready to make political capital against corporations out of the accident. On the other hand, as this trestle was built nearly six years ago, it is reasonable to believe that the piles driven outside of the channel would be likely to be decayed, if they have never been renewed. There seems to have been little or no longitudinal bracing between the pile bents, which contributed to the weakness of the structure. The enormous amount of trestling on the railways of the Northwest undoubtedly makes the cost of their proper maintenance very heavy. The Minneapolis, St. Paul & Sault Ste Marie, for example, according to its last report to the State railroad commission, has on the 230 miles of its lines in Minnesota only one iron and one wooden bridge; but it has 165 trestles with an aggregate length of 23,025 ft.. A well designed timber trestle with a good floor system is a tolerably safe structure while its timbers remain sound; but frequent and thorough inspection is necessary to determine their condition. A structure with unsound timbers is emphatically not a safe structure, although, like Howe's bridge, it may stand up "from principle" long after it would be generally expected to collapse.—Ed.)"

Modern diving appartus is being utilized for the recovery of treasure lost in New York harbor in Revolutionary days. The British man-of-war "Hussar," carrying nearly $5,000,000 in gold, was wrecked in passing Hell Gate during the Revolution, and sunk in 72 ft. of water. As noted in our issue of April 28, Capt. Thos. Simonds, of Leominster, Mass., recently formed a company to recover the buried treasure, and a dredge and divers are now working over the spot. Attempts made 25 years ago to recover the treasure were unsuccessful, partly because of the darkness on the bottom. The water of the East River is not especially transparent. The work now in progress is aided by an incandescent lamp of 65 C. P., carried by the diver on his helmet; a wrinkle worthy of being copied by those who dive for other things than treasure.

THE ENGINEERING SCHOOLS OF THE UNITED STATES.

XXII.

Degrees Conferred.

There is a very general feeling among practicing engineers, with which we fully sympathize, that the conferring of a degree of "Civil Engineer" upon young fellows who have never had a day of responsible work to do as such is not only no aid to them but morally indefensible, for the simple reason that it is telling a lie, knowing it to be such, and "a lie is made no more respectable by being solemnly engrossed on parchment and certified to by the president and faculty," as we once remarked in discussing this question. It is admitted that the arguments on the other side have a certain force, the chief argument being that it is not intended to deceive, but a well-understood convention, similar to that by which the young medical student is declared to be "learned in medicine" as soon as he has begun to know a little about it by three years' study, some three months of which combines some practice with it. But the analogy is hardly sound for this reason if for no other, that some sort of loud-sounding degree is a needful help to the young physician seeking patients, while it is neither a necessity nor a help to the young engineer seeking engagements. Neither is it clear, even if the argument be admitted, how it is made any more respectable for professors of engineering to tell lies on parchment because professors of medicine do so.

A large majority of the colleges seem to feel the force of these objections in some degree at least. If we may judge from Table XX.* only about one-third of the colleges, and a much smaller proportion of the strong and large colleges, confer the degrees of C. E., M. E., etc., upon their undergraduates. The practice of the 60 colleges tabulated in Table XX. may be thus summarized:

Degrees conferred.	No. of colleges.
C. E., M. E., E. M., etc.	23
B. C. E., B. M. E., etc.	11
B. E.	4
B. S.	11
B. S. in C. E., M. E., etc.	9
Ph. B.	2
Total.	60

Unfortunately, the apparent conclusion which these facts warrant is vitiated by the fact that all the colleges with a very few honorable exceptions (of which the Massachusetts Institute of Technology is one) have invented a method of whipping the devil around a stump so as to attain the same end, by a device which is certainly well calculated to tickle the sense of humor of any man who has any. They will not call the mere undergraduate C. E.; not they; he does not know enough; but after he has had three months to six months to twelve months experience in the field, or after he has taken another year or (in a few cases) two years of study under the college professors, then he knows enough! Then they can give him the degree of C. E. or M. E. with a perfectly clear conscience, and every last one of them does so with too few exceptions to speak of! Not only so, but quite a number of them will for this amount of study or practice or a little more, go still farther and dub a man a MASTER of Civil Engineering (!) or at least a Doctor. Even the Massachusetts Institute of Technology, which we have spoken of as an honorable exception, is perhaps, only a dishonorable one. It will not, indeed, attempt to dub a man a Civil Engineer at any time. It knows its limitations in that direction; but for only one extra year of post-graduate study, or five years in all, it will and does dub a man a MASTER OF SCIENCE! Heavens; what a title for any man to bear and not be ashamed, even after a lifetime of study!

Of course we all know the excuse for this; that it is by mere analogy from the Master of Arts degree; as truthful in the one case as the other; and that degree has come down to us through the centuries from the days when the man who could read a few Latin and Greek authors and knew a little geometry and logic was a true "Artium Magister," a master of all the arts there were. This may excuse the classical colleges for hanging on to the old form of degree. Its words are now "polarized,"as the Autocrat calls it, and mean no longer what they did. But "Master of Science" still means, and always will, precisely what it says; it means a being which can never exist short of Omniscience itself. What is that despicable trait of human nature which makes a man find it a pleasure and honor to be called what he knows he is not by men whom he knows to know that he is not what they say he is? Whatever it is, it is a pitiful evidence that poor human nature is still upon a pretty low plane of reason and morals.

* Published in our last issue.

Vacation Work Required.

The colleges will be seen to differ very considerably in this respect, most of them requiring no vacation work, but many of them requiring several weeks yearly. A reason for having no requirements which is doubtless influential with many of the colleges is that many of the students secure engagements which afford them actual practice in the field or the office during the summer; undoubtedly the most profitable kind of "vacation work" in every sense. While such engagements, if secured, should always excuse the engineering student from all other obligations during the summer, we cannot but feel that this column reveals a serious defect in the curriculum of most of our schools, which all of those which teach civil engineering, at least, would do well to correct.

Every engineer who has had experience in the field knows that there is no more delightful way of combining business with pleasure, and pleasure both of mind and body, than in a summer's outdoor work on a survey, especially if in camp. At least a month of the end of every year of an engineering course might be devoted with great profit to such a survey, preferably a railway survey in the nearest mountainous district. The men would not feel it a burden, but a pleasure, if properly managed. The expense would be small, the knowledge of practical field work thus gained of great use; often saving the young graduate from serving in a subordinate capacity for a year or two after graduation. The head of the party should preferably be a man of long practical experience in such work, who will hold the men up to the methods of practice, and not permit the dawdling and trifling which too often occurs in college so-called "field-practice." For this and other reasons the chief of the party should not be one of the college professors, unless he happens to have had good experience of the kind, but some one specially engaged for the work. There are plenty of old engineers who could and would arrange to pass a month in this way, for very moderate compensation, for the sake of their own health and pleasure. Even the students of mechanical engineering would profit greatly by this amount of experience thus gained in practical survey work, which they may often be called upon to do.

"Cutting Recitations."

The last column of Table XX., giving the number of recitations which can be cut without suspension, is rather of curious interest rather than of real value. A large proportion of the colleges report that they have no special regulations on this point but "treat their students as men and not as boys," and this will be more and more the tendency. It is not to be inferred from this column that there is any great difference between the colleges in this respect. The relative strictness of discipline, and its relative effect on conduct, is something which defies investigation by mere report of rules for conduct.

In our next issue we shall attempt the difficult task of showing about how much time is devoted to each leading study or class of studies at the different colleges, proportionately and absolutely. We bespeak in advance the indulgence of the reader for such imperfections of treatment as are all but inevitable in such a task.

THE JOINTS OF AMERICAN VITRIFIED SEWER PIPE.*

From a sanitary point of view the joints of all sewer pipes should be water-tight, in order that the sewage may not escape and pollute the surrounding soil. It is not necessary that the joints should be able to withstand any appreciable hydrostatic pressure, as sewers are usually designed to run but about half full. If vitrified pipe is used to convey water, the same requirement is necessary. When the pipe is laid on the hydraulic grade line, the joints are not subjected to any hydrostatic pressure, other than that due to the depth of water, immediately over the joint, hence the joints need to be only sufficiently tight to prevent leakage.

Under the conditions outlined above, the only require-

* A paper by Malverd A. Howe, Professor of Civil Engineering, Rose Polytechnic Institute, read before the Indiana Engineering Society.

ment at the joints is tightness against leakage; but there are many places where vitrified pipe might be used to advantage, provided the pipe itself and the joints could be relied upon to resist hydrostatic pressure. For example, it is sometimes necessary to carry a sewer under some obstruction, as a small ravine or stream, in which case the present practice is to use iron pipe; or the pipe line between a high and low reservoir cannot be located on the hydraulic grade line, and consequently the engineer hesitates to depart from the general practice of using iron pipe, although the vitrified pipe makes a much superior conduit for water.

From a series of experiments recently made by the writer, he determined that the average vitrified pipe as now made will be on the point of rupture when subjected to a hydrostatic pressure of 100 lbs. per sq. in., the average tensile strength of the material composing the pipe being 600 lbs. per sq. in. (Pipes having a diameter less than 12 ins. will have greater resisting power against bursting, being proportionately thicker than the 12-in. pipe.)

This pressure corresponds to a head of about 260 ft., which shows that as far as safety against bursting is concerned, vitrified pipe is perfectly safe for all heads less than 50 ft. (using a factor of safety between 4 and 5.)

The following table gives the average ultimate tensile strength of pipe of various diameters:

Nominal Diameter, ins.						
4	6	8	10	12	18	21	24
Average tensile strength, lbs. per sq. in.							
517	578	552	702	592	529	617	856
No. of results averaged.							
16	25	26	15	29	1	3	2

In conjunction with the hydrostatic tests, a series of experiments were made to determine the resistance of the joints. The following types were tested:

Type A—The ordinary bell and spigot joint as shown in Fig. 1.

Type B—The corrugated bell and spigot as shown in Fig. 2.

Type C—The ring joint as shown in Fig. 3.

The accompanying table gives the composition and size of joints and the results of the tests:

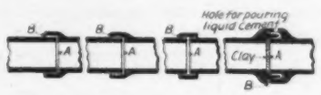
Results of the Cement Joint Tests.

Type of Joint	Nominal diam. ins.	Av. thick. of cement joint, ins.	Av. depth of cement joint, ins.	Composition of Mortars. (Louisville Black Diamond Cement.)	Age of joint, days	Pressure, lbs. per sq. in.	Method employed.	Remarks.
A	10	0.35	1.40	Neat	21	None	1	Broke
A	8	0.50	1.50	"	41	50.0	2	"
A	12	1.50	4.50	"	33	115.0	3	Joint leaked
A	6	0.26	1.40	"	33	198.0	2	Broke
A	12	0.25	1.75	"	21	6.0	3	Joint failed
B	8	0.28	1.70	"	16	50.0	1	Broke
B	6	0.44	1.64	1c.2s by wt	14	None	2	Joint failed
C	12	0.44	1.85	Neat	28	17.5	3	" "
C	8	0.50	1.80	"	21	None	3	" "
C	6	0.34	1.80	1c.2s by wt	14	None	3	Pipes injured
D	8	0.27	1.78	Neat	21	17.5	3	Joint failed
D	6	0.34	1 63	"	21	25 0	3	" "
G	12	0.50	1.83	"	21	12.0	3	Broke
G	6	0.34	1.75	"	21	17.5	3	"
H	8	0.56	1 90	1c. 1s by wt	6	12.0	3	Joint failed
H	6	0.30	1.80	"	6	25.3	3	" "
P	12	0.24	3.05	Neat	6	37.5	3	Broke

In methods No. 1 and No. 2 the pipe was prevented from moving longitudinally by clamps; and in method No. 3 the pipes were prevented from moving away from each other longitudinally only by the friction in the joints.

From the table, it is seen that when method No. 3 was employed, no great hydrostatic pressure could be applied before the joint failed, the maximum pressure for Type A being 25.3 lbs. per sq. in., which corresponds to a head of about 58 ft., making the joint about one-fourth as strong against failure as the average pipe. In these experiments, when the joint failed, the pipes were usually forced apart by water entering the space (a), Fig. 1. It is noticeable from the table that the space to be filled with cement is quite variable for pipes of different makes, and in nearly every case is too small to insure a full joint without great care being exercised.

A single experiment was made with the corrugated bell and spigot, method No. 3 being employed. The space to be filled with cement and the corrugations, was so small that it was impossible to fill the joint with cement mortar, but even then the joint proved stronger than any of Type A. Although one experiment does not furnish sufficient ground upon which to base an opinion, yet the behavior of the joint during the experiment leads the writer to believe that such a joint can be made which will be as strong as the average pipe, and will prevent not only leakage, but any tendency to separate.



One experiment was also made with the ring-joint, using method No. 3. The joint proved to be much stronger than any mentioned above, and stronger than the average pipe. This joint was carefully made with an unbroken ring, and doubtless would have held until the pipes broke had not water entered the space (a). The joint has the advantage of plenty of space for cement, it being much thicker and longer than in Types A and B.

With Type A and method No. 2, even greater strength was found, showing that the pipe must be prevented from moving longitudinally.

From the results of these experiments it is evident that Type A can not be used under a hydrostatic head, the space for cement being too small and there being no means of preventing longitudinal movement otherwise than by the friction of the cement and pipe. Type B is an improvement over Type A, but the space for the cement and the corrugations should be larger. Type C is a good joint to prevent leakage, but is not reliable under hydrostatic pressure. The joint could be improved by corrugating the ends of the pipe and the inside of the ring.

There is an English joint which is superior to the American joints, both in filling with cement and tightness. It is called "The Archer Improved Water-tight Joint." The essential features are shown in Fig. 4. The joint is filled by pouring liquid cement into the hole at (c), thus insuring a full joint. If water enters at (a), the pipes will be forced apart as in Types A and C, so that this joint is not perfect, requiring the improvement which will prevent longitudinal movement in the joint. The writer will leave this improvement for the inventive mind of some reader.

FILTERS AT THE WORKS OF THE LONDON & NORTHWESTERN RAILWAY AT CREWE.

We illustrate this week a filter plant built by Halliday & Co., of Manchester, England, for the works of the London & Northwestern Railway, at Crewe, and which has been in service since the early part of 1889. For the accompanying cuts and description of the plant and operation we are indebted to "Engineering," of London.

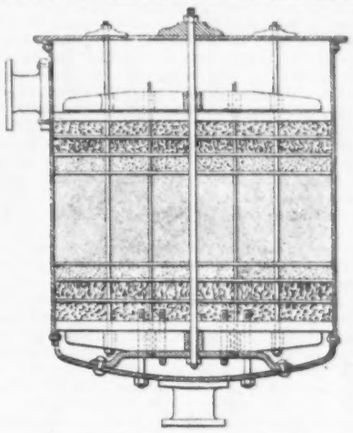
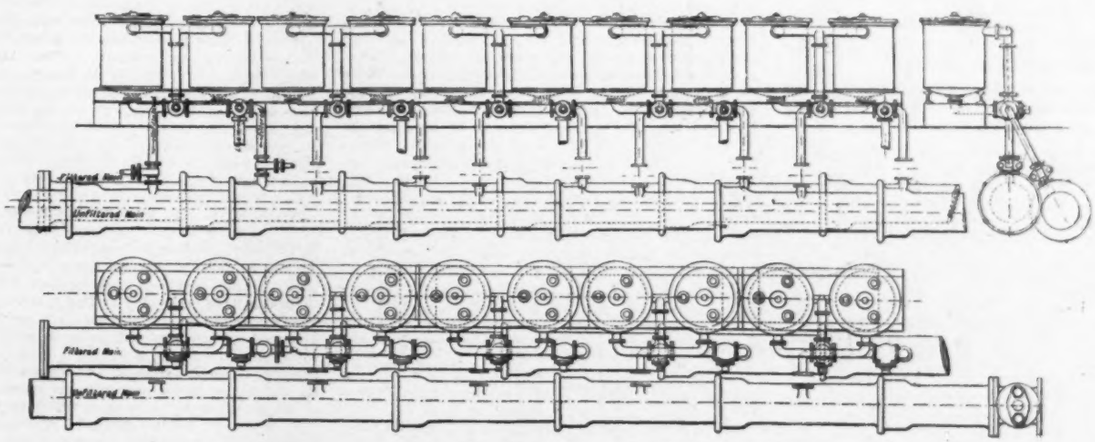


Fig. 3. Section of Filter Cylinder.

There are five filters on the one line of pipe, as shown by the elevation and plan (Figs. 1 and 2), and the number could be increased indefinitely to suit requirements. The two cylinders (Fig. 3), of each filter are made of an outer casing of ½-in. steel plates, with the bottom of one ⅝-in. plate dished out, while the top plate is ⅝ ins. thick. The bolts are ⅝ ins. diameter and are placed 2¼ ins. c. to c. The inside is fitted with two strong cast iron plates perforated, over which are placed galvanized steel-wire wove sheets. There are also four skeleton rings of cast iron. These are also covered with wire sheets. The plates and rings have holes to receive seven staybolts, which pass through them and, by means of ferules, keep all the parts in place to receive the animal charcoal which is placed into position and pressed. The filter tap may be arranged to pass the water without going into the filter. By turning the plug a quarter circle with a lever, the water is turned into the bottom of the filter, passes through the filter bed, and out at the top, down the pipe, into the tap again, and into the filtered mass. By turning the plug another quarter of a circle, the water current is reversed, the water passing in at the top of the filter, and washing out of the filter the solid matter that has been collected while the tap has been at "filtered." A three-way tap is also provided, so that when the filters are being cleaned, the cleansing water is turned to waste. Both these taps are 5 ins. diameter, made with brass plugs, brass lined, with cast iron cases, and are worked with a wrought iron key or lever 3 ft. 6 ins. long. They are easily worked by one man. The pipes are 5 ins. in diameter, with flange-faced joints. Each filter when filled and complete weighs about 7⅛ gross tons.



FIGS. 1 AND 2. ELEVATION AND PLAN OF FILTER PLANT AT CREWE, ENGLAND.

The railway company, besides satisfying its own requirements, supplies the corporation by meter from its main. The water is taken from a reservoir 12 miles from Crewe, and passes along the company's line. The filters are placed close by the passenger station, and the 14-in. main passes into the filter-house, the whole supply being dealt with by the five filters. The filters are calculated to deal with 60,000 to 70,000 gallons per hour, and this quantity is passed at certain hours of the day, when more water is used for domestic purposes. The actual consumption from Sept. 1, 1889, to May 27, 1892, was 347,000,000 gallons, or, divided into 1,000 days, equal to 347,000 gallons per day of 24 hours, Sundays being included. The cost of maintenance from Sept. 1, 1889, to May 27, 1892, was $1,445, or an average of $1.39 per day, or say 5,000 gallons of water filtered for 2 cts. This, too, will probably be considerably reduced as the filters work for three or four months beyond the date given. The cost for cleaning is for a laborer one hour each day, equal to 8 cts. per day.

The cost of plant, in the first instance, for five filters, including foundation, connecting pipes, and valves, was $10,000, and for the building $1,250, together $11,250. The cost of working given, 2 cts. per 5,000 gallons, does not include interest on first cost of plant, nor depreciation. It should be borne in mind, on the other hand, that the filters are not worked up to their full capacity, nor is the charcoal used to its full extent; for when the filters show 3 lbs. less pressure at the delivery or filtered pipe than at the unfiltered or main pipe that serves the filters, the charcoal is renewed. There is a gage on the main that supplies the filters, and another gage on the pipe for the water after it passes through the filter; and if the difference be 3 lbs. the charcoal is renewed. It might be used longer, in which case the cost of working would be still less, but there would be a loss of pressure in the distributing mains. Again, the charcoal, if reburnt, might be used again with a make-up of new material, but the quantity used, three tons, is too small to warrant retorts being constructed. The old charcoal may be sold for $10 to $15 per ton, so that all circumstances point to even more favorable results than those given.

RIVET DIAGRAM FOR PROPORTIONING PIN CONNECTIONS.

We are indebted to Mr. C. H. Wright, of the Edge Moor Bridge Works, for the original of the "rivet diagram" reproduced herewith, which is designed to furnish a simple and convenient method of determining the bearing plates required at the joints of pin-connected spans and the number of rivets required in each.

The method is so simple that the brief example given will make it plain.

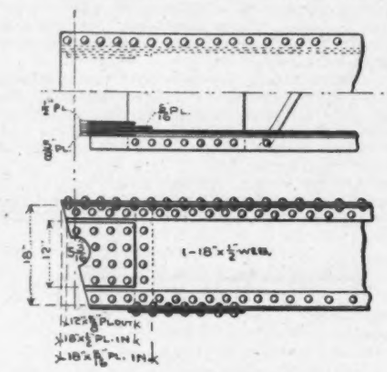
The diagrams having once been made for the various values of shear and bearing used in steel and iron, the work of figuring the pin bearings is almost nothing.

In the accompanying example the given particulars are as follows:

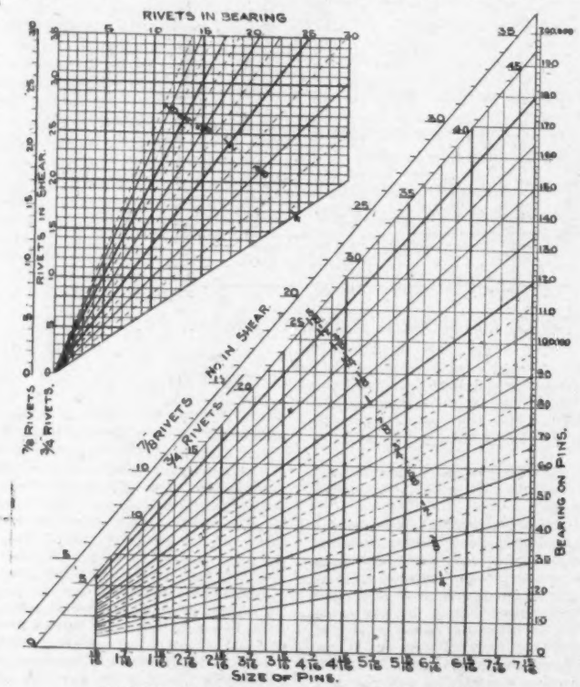
Allowed bearing on pin..... 15,000 lbs. per sq. in.
" " " rivets..... 15,000 " "
Shear of rivets..... 9,500 " "
Strain in member.....300,000 lbs.
5 3-16-in. pin, 1 to ½-in. web, use ⅞-in rivets.

It is required to find the thickness of plate necessary for "bearing," also the number of rivets required in pin plates. 300,000 lbs. in member would be 150,000 lbs. on each web. Using the diagram having the given values, we find that a 5 3-16-in. pin requires 1 5-16 in. of plate for 100,000 lbs., and ⅞ in. of plate for 50,000 lbs.—1 5-16 in. + ⅞ in.=1 15-16 in., is required for 150,000, and 1 15-16 in.—½ in. web=1 7-16 in. of pin plates, ⅝ in. + ½ in. + 5-16 in.=1 7-16 in.—Use ⅝-in. plate outside, and ½-in. and 5-16-in. plates inside. From the same diagram we find that with the 5 3-16-in. pin, 12 rivets are required in a ⅝-in. plate; we will use 13. Now it is desired to know how many of these 13 rivets can be counted on the other side. From the small diagram we find that 13 rivets in ½-in. web=17 rivets in shear 17—13=4 ins., the number that can be used on the other side. Refer again to large diagram: ½-in. plate requires 10 rivets; and as 4 in the ⅝-in. plate can be counted, we must have 10—4=6 new rivets; or, 13 + 6=19 in all. As spacing is arranged we will use 7, or 20 rivets in all.

The 5-16-in. plate requires 6 rivets in shear; but, by small diagram we see that 7 rivets are required in bearing in 5-16-in. plate to equal 6 in shear.



Example of Riveted Bridge Member.



RIVET DIAGRAM, EDGE MOOR BRIDGE WORKS.

(Constructed for values of: Bearing of Pin, 15,000 lbs. per sq. in.; Bearing of Rivet, 15,000 lbs. per sq. in.; Shear of Rivet, 9,500 lbs. per sq. in.)

ELECTRICAL MEASURING INSTRUMENTS.

In a recent paper before the Institution of Civil Engineers, Mr. Jas. Swinburne described the principal forms of instruments used for electrical measurements. The vast strides made during the last ten years in the commercial use of electrical energy has brought about a complete change in the methods of electrical measurement. There are now workshop as opposed to laboratory instruments; but they are made in such quantities as to permit of a moderate selling price, with great accuracy in their indications. The author's paper was devoted to this class of instruments, excluding those methods of measurement which are the same in the workshop as in the laboratory, such as taking resistance with an ordinary Wheatstone bridge.

Voltmeters and Ammeters for Continuous Currents.—Since very many of these two classes of instruments differ only in their windings, they may well be discussed together. There is, however, one point of difference to which more attention is now being paid; that is that for use in central stations and private installations, a voltmeter should give clear and accurate readings through a small range. For instance, a station supplying at 100 volts does not require its voltmeters to read from 10 to 150 volts, but should be provided with instruments whose whole scale is devoted to readings between, say, 97 and 103 volts, if there are no feeders. The amperemeters, on the other hand, may be used for any currents up to their maximum.

Stress is laid on these points because they are not generally realized either by instrument-makers or purchasers. For years designers have been devoting unlimited ingenuity to making instruments with equally-divided scales. An equally-divided scale is of no value, and, to secure approximately proportional readings, other important considerations in the design may have to be sacrificed.

In addition to giving the readings required, all instruments should be direct-reading—that is to say, the index should point to the pressure or current, and there should be no turning of buttons on the top, or of reference to tables. Instruments whose indexes have to be brought to zero, such as the well known Siemens dynamometer, have been of enormous value in the past, and have not yet been quite replaced in alternate current work; but though indirect-reading instruments have still to be used in many cases, they should be avoided in central-station work. All instruments should have bold and visible scales, the dials being vertical, so that it is not necessary to go up close to the switchboard to take a reading.

Nearly all makers are now adopting the clock form. It is generally more troublesome to make instruments in this way, because the forces dealt with are so small that it is difficult to make the pivots free enough to give accurate readings. Instruments with horizontal dials can have suspended moving systems, but the advantage to the maker is generally more than counterbalanced by the disadvantage to the user. In addition to these requirements, instruments must not have their readings affected by changes of temperature, produced by the electric power wasted in the coils, or by change of temperature of the room in which they are placed, and they must not be affected by external magnetic fields, which are always strong and variable in direction in electric stations. For use at sea there is another requirement still—that the movements of the vessel should not affect the readings. It is most important that station instruments should be always in circuit without using much power. If station power is taken at 4 cts. per kilo-watt hour, every watt lost in the instrument is equal to the interest on $4.86 at 7%. Exacting as these requirements are, they have all, or nearly all, been already filled by the various leading instrument-makers.

Of the hosts of varieties of voltmeter and ammeter that have been designed, only a few have survived; and, curiously enough, the most successful form is one that was at first regarded with the most suspicion. The majority of these instruments are now made with soft iron cores acted upon by coils in various ways. Such instruments were considered unpromising because they cannot be made to give proportionate scales except by empirical means, and because magnetic hysteresis gives rise to errors. It is now generally realized that proportional scales are not important; and the errors due to hysteresis have been reduced by careful designers till they are no longer perceptible. To avoid these errors, all that is necessary is to arrange the soft iron parts of the instrument so that only a small portion of the excitation due to the coil is spent on the iron. This means either that the induction in the iron must be very low, in which case the forces dealt with are small, or that the excitation due to the coil must be large, in which case there is waste of power and heating. High induction thus cannot be produced with few ampere turns, as the magnetic circuit must be chiefly through air. If it were chiefly

through iron, the hysteresis errors would be considerable.

The force acting on the moving system may be opposed by gravity or by springs. Most engineers have more confidence in gravity instruments; at the same time, springs are often very convenient and must be employed for marine use. Their permanence has been frequently questioned; but, according to Kohlrausch, a good spring is absolutely trustworthy. Some springs creep, or take permanent or temporary sets, which may give rise to errors; but with care in selecting the material and in tempering, there should be no appreciable inaccuracy.

The author then briefly describes the essential features of 25 different forms of volt and ampere meters. The class in which the field due to the coil is modified by the presence of a fixed core or cores, and the needle is so arranged as to tend to move from a weak into a strong field against a weight or spring, he considers preferable to the simpler form in which the needle turns on a center. The former class of instruments are not so easily affected by external fields, because the north and south poles of the needle move in the same direction. The needle, therefore, cannot set itself in the direction of any external field, as the direction of the needle remains the same throughout the readings. Among other classes described are those employing permanent magnets, those which depend on the heating of the wire by the current, of which the Cardew voltmeter is an example; those employing a standard cell, and those involving electrostatic action. Among the instruments de cribed by the author are those of the American inventors, Thomson, Edison, Weston and Hopkins.

Alternate Current Voltmeters and Ammeters.—Many instruments already described will do equally well for continuous and alternate currents. This is the case more especially with ammeters. Of course all instruments with permanent magnets are out of the question for alternate current work. A soft iron ammeter, which is so arranged that the iron does not produce hysteresis errors with continuous, will generally work with alternate currents, if the iron is laminated so as to avoid Foucault currents. In order that such an instrument shall work correctly, it is necessary that the force at every part of the period should be proportional to the square of the current. If the induction is strictly proportional to the current, the reading is thus correct. If the induction is appreciably affected by hysteresis there is an error. If there are any Foucault currents in the iron core, or in the brass work of the instrument, the iron is not fully magnetized, and the reading is too low.

In order that a voltmeter should be available for alternate currents, it must be made with no appreciable time-constant, else it reads too low. It can, of course, be calibrated for a particular frequency; but that is not of much use, as stations do not keep accurately enough to stated speeds. By far the most generally used alternate-current voltmeter is the Cardew. It acts just as well with alternate as with continuous currents. Most alternate stations run at 1,000 or 2,000 volts. The electrostatic form of instrument is, therefore, much the best, as it is easily made, and takes no power. Such instruments will, of course, work equally well with alternating or continuous currents.

One of the most complicated questions in connection with alternate currents is the measurements of power. The ordinary wattmeter, as used in continuous current work, consists of a fixed and movable coil. One is of thick wire, and is used in series with the current, and the other is in shunt, and takes a current proportional to the pressure. The force acting on the moving coil is then proportional to the product of the pressure and current, that is to say, to the power. This instrument is exceedingly useful in incandescent lamp testing, but it demands a correction. If the pressure coil is put in shunt to the lamp only, the current coil takes the current of the lamp and the current of the pressure coil, so that the reading is too high. If the pressure coil is arranged in shunt to the lamp and current coil, it has the extra pressure due to the drop over the resistance of the current coil, so that the reading is again too large. In fact, the wattmeter really reads the power spent in the circuit to be measured plus that spent in one of its own coils. This error can be compensated so as to make the instrument read correctly, but this compensation is necessary only when small powers are to be read. Though an ordinary wattmeter, as used for continuous current, is not suitable for alternate work, there is no real difficulty in making an instrument which is sensibly correct with alternate currents. The current coil should produce a strong field, and the pressure circuit should have comparatively few turns on the moving coil, a non-inductive resistance being arranged in series with it. There is an undeserved prejudice against the dynamometer wattmeter. On the other hand, the same instrument, arranged so as to have greater errors, and called a split dynamometer, has, till lately, been treated as accurate.

Several methods of measuring power by electrostatic instruments have been proposed. The electrostatic analogy of a dynamometer watt-meter cannot be found, for the mutual attraction or repulsion of two electrified bodies is as the square of the difference of potential, while in the dynamometer the force is as the product of the currents in the coil. All methods of measuring alternate power electrically, involve non-inductive resistance, and, therefore, they all have the same error, from such resistances not being accurately non-inductive.

There is no difficulty in making a resistance which has no sensible time-constant. The author's form of wattmeter has a moving system, consisting of a few turns of wire, with a non-inductive resistance in series, and this form of instrument is accurate within the limits of observation. Put on an inductive circuit with 100 volts and 5 amperes, which was known to have a loss of about 12 watts, the instrument read within 2 watts of the calculated power. On a condenser taking 2,000 volts and 3 amperes, or an apparent power of 6,000 watts, it gave no deflection. If a little care is taken in designing, so that there is no appreciable self-induction, and if a little trouble is taken in manufacturing, so that there is no leakage across the resistance, even under pressures of several thousand volts, alternate current power can be measured as easily and as accurately as in the case of continuous currents.

Resistance Measurements.—The comparison of electrical forces can be made with greater accuracy than any other kind of measurement. A good chemical balance will weigh within 1 in 100,000, but electric pressures, currents or resistances can be compared within 1 in 1,000,000. Electrical measurement is less accurate than weighing, solely because of the difficulty of preparing constant standards. Resistance-boxes can be made with great accuracy, and can also be easily checked; the result is that an engineer who is quite satisfied with a voltmeter which may be 1 or 2% wrong, insists on having a bridge which is accurate within 1 in 10,000 or 100,000, costing well on to $150. Apart from the excessive cost of such apparatus, it is not suitable for practical work. Plugs are the best means of making good contacts, if they are well made and are kept thoroughly clean. The plugs of most resistance-boxes are not well enough made, and are not kept clean. Resistance-boxes for commercial work should therefore be made with switches. A switch can be made to give a very good contact; but even if it did not a switch-box still comes out better than most plug-boxes.

There is a lack of resistance-boxes meeting electric light requirements, and instrument makers should turn their attention to apparatus for measuring very high and very low resistances. For measuring insulation, Mr. Evershed has brought out an ingenious apparatus consisting of an ohmmeter and a tiny dynamo. The latter develops the pressure, thus avoiding the necessity for cells, and the ohmmeter measures the resistance. Apparatus of this class may seem rough, as the speed of turning may alter; but if the operator always tries to turn it at 60 revolutions per minute the speed will not vary more than 10 or 15%, whereas the insulation resistance of a given installation frequently varies 100% from day to day, owing to minute leaks over damp surfaces.

Meters.—By far the most important instrument of all is the meter. The pressure and current indicators in a station cost little in comparison with the heavy plant; but the question of meters is most serious because one must be provided for each customer, so that they are very numerous. The requirements are that the meter should be accurate throughout its load. For years electric supply companies, especially those using alternating currents, have been obliged to content themselves with meters in whose favor all that can be said is that they go faster if the load increases. The enormous difference in the revenue due to inaccurate meters does not seem to be fully realized. A meter that reads 2 or 3% wrong, may make all the difference between working at a loss or at a profit. It may be urged that inaccuracy does not matter, because it tends to average about right. This is, however, very doubtful. The inspector is not likely to pass meters that read much too high at any parts of their range; and most give too small readings at light loads. It is most advisable that meters should start with a single lamp, out of at least 100. Very few motor meters come near this. Suppose a house is wired for 100 lamps, and its average load is equal to 10 lamps always on; and suppose one lamp is burning all day in a dark passage, but is not counted by the meter. The error is 10% against the supply company. If the company were to replace the meters by some accurate form they would increase the revenue 10% with no extra expenditure, which is enough to turn a failure into a brilliant success. Errors due to temperature variations may frequently be 10% or more if copper is used. As a matter of fact copper is often used in some forms of meter, owing to the high resistance of alloys with low temperature co-efficients. Meters which are correct when adjusted at the same temperature may vary very largely if one is placed in a cold cellar, and the other in a warm front hall or in a kitchen.

It is most important that the meter should not itself waste power. If the cost of extra energy is taken at only 4 cts. per kilowatt hour, ever watt lost in the shunt circuit of a motor meter costs 35 cts. per annum. Taking interest and depreciation together as high as 7%, this means $5. That is to say, the price of the meter must be considered as increased by $5 for every watt taken in the shunt circuit; so that a $75 meter which has no continuous waste is to be preferred to a $25 meter that takes more than ten watts continuously. The various sources of error can best be discussed in connection with particular forms of meter. It is questionable whether any parts of a meter should be allowed to go at high speeds. A motor meter with an armature running at 1,000 revs. per minute will probably wear itself out soon, but it is difficult to say whether the speed should be limited to something like 100 or to about 10 per minute. The balance of a watch performs 300 reciprocations per minute for many years without perceptible wear. Other things being equal, of course low speeds are best. A meter should not cause a drop by setting up a perceptible back pressure, or by absorbing too much power in resistances. The loss of 1% means not only a waste of 1% of the energy paid for, but that the lamps will be run some 5% under candle power, so that the consumer gets 5% too little light, and cannot run his lamps properly. A quarter, or, at the very most, half a volt in a 100-volt installation is all that should be allowed as full-load drop in the meter. A meter should be direct-reading; preferably it should have an index like that of a gas-meter. This is not a matter of real importance; it is a concession to prejudice. When gas came into use gas chandeliers were made, and it was pretended that candles were being burnt. Now that electric light has been introduced, the fittings are altered a little more, and it is pretended that gas is being used. The chief advantage of direct-reading is that it allows the consumer to see how much he is using, and this gives hime confidence. It is still usual for makers to send out meters whose readings have to be multiplied by a constant. This slovenly practice will probably soon die out. It used to be common in the case of volt and ampere meters, but is now discarded in instruments of the best types.

It is questionable whether mercury is admissible in a meter. Mercury appears to give trouble when used in connection with a commutator. The surface is apt to become oxidized, and the mercury separates into a number of minute globules. Many forms of meters have mercury whose surface is not changed, the moving part being wholly immersed. In this case the mercury is not likely to become "dead." The next trouble is amalgamation. Even the vapor of mercury will amalgamate. The train and all the mechanism must therefore be made of iron, steel or nickel. Nickeled brass will stand for a time, but electro-deposited nickel is so porous that it is questionable whether mercury will not eventually destroy any meter containing brass, tin, or copper. These statements as to the action of mercury are open to contradiction, and the results of experience extended over some years would be valuable.*

All the parts of the meter should be strong, so that the mechanism is not likely to go wrong. All sorts of watchwork are to be discouraged. A meter containing any kind of delicate mechanism may work on the test-room table; but it is quite another thing when it is in practical use. At present, while electric light is, to some extent, a novelty, the housing of the meter receives some little extra attention; but it will soon share the fate of the gas-meter, and be put in any out-of-the-way cellar, where it will be exposed to dust and damp, and perhaps traces of corrosive gases. In addition to this, most meters are slightly warm, and this attracts all sorts of insects, which can usually find entrance if the cases are not very carefully closed. Many meters are stopped by insects; and it is foreseeing such contingencies and providing for them, that constitutes the principal difficulty in developing a new industry.

Above all, it is necessary that meters should be cheap. There is no difficulty in designing a beautiful meter which shall cost $100 to $200, but that is not the problem. What is required is a meter which is accurate enough for commercial use, and which costs as little as a gas-meter or even less.

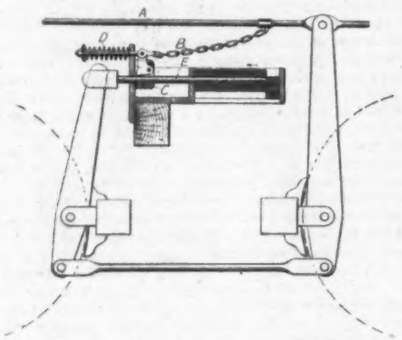
(To be continued.)

A storage battery car in operation on the Washington Park St. Ry., in Sioux City, Ia., has its batteries changed every 25 1-3 miles. The coal used to generate the electricity averages 9½ lbs. per car mile. Slack costing $1.52 per ton is used, making the total cost for fuel about ⅝ ct. per car mile. The Bradbury-Stone battery is used.

* At the close of the discussion the author said he had afterward been informed that the vapor of mercury would not affect brass mechanism.

A NEW AUTOMATIC SLACK ADJUSTER FOR AIR BRAKES.

With the increasing use of the air brake on freight cars the necessity of looking after the brake gear and all that pertains to it has become clearly manifest. The ordinary hand brake can be turned until the shoes are pressed against the wheels with all the force which the brakeman's strength can exert; the only effect of weak brake beams and worn shoes is to make it necessary to take up more slack before the brake is applied with its full force. But when the brakes are applied by compressed air the case is altered. The force of the piston is applied to the brake shoes through a series of levers so arranged that the pressure on the piston is multiplied to a pressure perhaps five or six times as great on the brake shoes and hence a travel of five or six inches of the piston causes only any inch or so of movement of the brake shoe. With even the best brake gear there is a certain amount of slack in the connections, and when the load is applied there is stretching of the rods which transmit the strain and bending of the brake beams. These causes combine to increase the travel of the piston



The Parke Slack Adjuster for Air Brakes.

necessary to produce a given pressure on the brake shoes; and either weak brake gear or worn brake shoes may so increase the travel of the piston as to bring it to the end of the cylinder, against which it will exert its force.

An appreciation of these facts has led railway officials to very generally adopt metal brake beams and the M. C. B. standard brake gear for air braked cars. Further, by the code of rules adopted at the Master Car Builders' convention last June, it is the duty of car inspectors to take up the slack whenever the piston travel on a freight car brake exceeds 9 ins. so that it will be not more than 5 ins. or less than 6 ins. To facilitate this work several piston travel indicators have been brought out (see Eng. News, Dec. 20, 1890); but even with their aid the frequent adjustment of slack is quite a tax on the car inspectors or would be if the slack on all the cars was taken up as frequently as it should be. A number of inventors have therefore turned their attention to the production of a device for taking up the slack automatically, and one or two of these are already on the market.

We illustrate herewith an automatic slack adjuster which will attract attention at once on account of its origin. It is the invention of Mr. R. A. Parke, of the Westinghouse Air Brake Co., whose experience has qualified him especially well to cope with the problem, and a half interest in the patent is assigned to Mr. H. H. Westinghouse. Several of the brake-slack adjusters for which patents have been issued accomplish their purpose by varying the length of the connecting rod between the brake beams. Mr. Parke's device, however, effects adjustment by moving forward the abutment against which the upper end of the dead lever bears. In the accompanying cut the position of the dead lever with reference to the truck is seen, and the automatic adjusting gear is shown in section. In operation, when the piston travel exceeds a certain amount the rod A is pulled so far to the right that the chain B is drawn taut, carrying the sliding collar C also to the right and compressing the spring D. As soon as the brakes are released the spring draws the collar back to its first position; but while the collar slides freely on the rod E, when moving to the right, the pawl which it carries forces the rod E to move with it when the movement is in the reverse direction. As seen by the cut, it is this rod E which receives the thrust of the dead lever. The rear end of the rod E is carried in an iron box and is covered with washers. As the rod is pulled forward, the washers behind it fall down, preventing the rod from moving in the reverse direction. The washer box is made with a slot on the under side, so that when new brake shoes are put in the washers may be lifted by inserting a thin piece of iron in the slot, and the rod E may be moved back till it touches the right hand end of the box.

In his patent (No. 480,341, dated Aug. 9, 1892), Mr. Parke shows several methods of accomplishing his purpose. In one a second pawl replaces the washers and in another the live truck lever instead of the dead lever is adjusted. He claims the following advantages over the class of adjusters operated by changing the length of the connecting rod: 1. The connecting rod is under a much greater strain than the upper ends of the truck levers. 2. Should an adjusting apparatus on the upper ends of the truck levers break, the action of the brake is not hindered and the adjustment can be made by hand. With a connecting rod adjustment, however, a breakage may drop the rods on the track and cause a derailment. 3. As the upper end of the truck lever moves much farther than the lower end, a given motion of the adjusting apparatus in the position chosen by Mr. Parke regulates piston travel more closely than in the lower position. While other patents have been issued on brake adjusters regulating the position of the upper ends of the truck levers, Mr. Parke claims that such devices have employed ratchet and windlass motion and are less simple and practical than his device.

ECONOMICAL ELECTRIC LIGHTING.

Prof. George Forbes, consulting electrical engineer to the Cataract Construction Company, of Niagara Falls, suggests in a paper read before the British Association, in Edinburgh, a possible economy in the generation of electric light in that city. As equally good conditions may exist elsewhere, his suggestion is worthy of general study.

He first calls attention to the loss by having to fire up boilers for a 2-hours' run in each 24, and the low efficiency of coal used in this manner. Prof. Forbes said that the only cure for this difficulty was some system of storage, and the presence of high ground in the immediate vicinity of Edinburgh furnished the means. He proposed the formation of a reservoir, near Arthur's Seat, by throwing a dam across a ravine. This reservoir would be 725 ft. above the sea, or 642 ft. above Loch End. Water is to be pumped into this reservoir by engines running constantly at full speed; and this stored water was to be led by pipes to a system of turbines operating dynamos one mile distant, at Loch End.

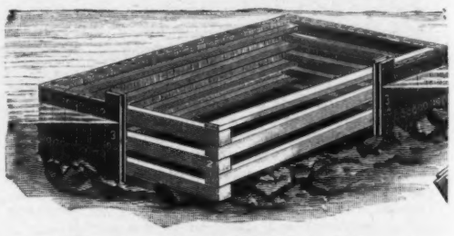
Prof. Forbes figures that the reservoir would hold a quantity of water equal to 28,000 HP. working for one hour; with the assumption that there was 75% efficiency in the turbines and pipes. The cost of the pipes leading to Arthur's Seat would be about $5 per HP. With engines constantly supplying power and storing what was not immediately wanted, the author showed that he could supply 12,500 HP. at the central station, and to this is to be added 3,000 HP. continually working in the form of steam-engines, or 15,500 HP. in all. As 28,000 HP. is available in the reservoir, the cost of the difference, or about 12,000 HP., is saved, in boilers and engines, costing probably $1,000,000; and for this is substituted pipes, turbines, pumps and reservoir, costing about $175,000.

Pumping engines and turbines are now so perfect that the author believes that it is possible to obtain one HP. delivered from each 3 lbs. of Welsh coal. Experience shows that, including the coal wasted in getting up steam and banking fires, even the best appliances at central stations demand 5 lbs. of coal for every HP. Taking the maximum demand in winter as being six times the mean demand, we have 2,600 HP. all the year round. The saving of 2 lbs. of coal per horse-power-hour amounts to 20,000 tons per year, or say $100,000 annually. And Prof. Forbes thinks that this amount could be saved by utilizing existing natural advantages at Edinburgh.

The author further suggests that the use of destructors for getting rid of city refuse, and at the same time getting up steam for electric lighting, will assume more importance in the future. As the refuse should be burned day and night, and electric light is only wanted for part of the 24 hours, some system of hydraulic storage as here described is essential for economy. Otherwise the heat from the destructors would be wasted for much of the day. From numerous experiments made in refuse burning, Prof. Forbes believes that in the great majority of towns, 10 lbs. of the ordinary ash-bin refuse, as a heat producing power, would equal one pound of ordinary coal.

SHEET PILING FOR COFFER-DAMS ON ROCK BOTTOM.

The use of sheet piling in mud, gravel and sand bottoms is common, but we have never before heard of an attempt to use it on a rock bottom. This has recently been done successfully and at a great saving in cost, according to the statement of the engineer in charge, by the use of piling furnished by the Wakefield Sheet Piling Co., of Chicago, whose peculiar and novel system of sheet piling was described and illustrated in our issue of April 16, 1892. So complete a description has been given by Mr. H. F.



Coffer Dam of Wakefield Sheet Piling.

Baldwin, Chief Engineer and Superintendent Maintenance of Way, Chicago & Eastern Illinois R. R., on which road the work was done, that we reprint the letter in full as follows:

In construction of our second track over Kankakee River at Momence, Ill., it was necessary to extend the piers in that river. The bottom is limestone and the surface is very irregular. We tried several days, and finally succeeded in constructing a coffer-dam with two parallel walls of sheet piling; we then tried the Wakefield triple lap piling, constructed of inch boards sharpened to an edge, 2½ ins. tongue and groove, which were driven with sledges until the piling, which was soft pine, conformed to the uneven surface of the rock. This piling was driven around cribs loaded with stone, and after piling was driven, gravel was put outside of the coffer-dam, after which no special trouble was experienced in pumping out the water. The cost of one of these coffer-dams was not more than one-third that of the first one we constructed and took about one-quarter as long to construct.

At the time this was accomplished there was 4 ft. of water in the river and a 5-mile per hour current.

PROTECTION OF RAILWAY TRACKS AGAINST TORRENTS AND EARTH-SLIDES IN SICILY, ITALY.

The construction of railway lines in the southern part of Italy and Sicily is accompanied as a rule by peculiar difficulties, which are caused by the conditions of the climate, the general formation of the mountains and the scarcity of wooded slopes. During the heat of the dry summer and the cloudburst-like rains of the winter, which combined cause deep crevices in the rocks of the mountain slopes, great masses of boulders and rocks are detached and carried down the valleys. In softer ground, especially clay and marl, the water penetrating through the crevices formed during the summer months causes the loosened masses to slide down hill, thus endangering the railway. Mr. H. Keller contributes to the "Centralblatt der Bauverwaltung," an illustrated article on the precautions taken against these difficulties, which were in substance as follows: The dimensions on the accompanying illustrations are in meters. The work of securing railway tracks against torrents and earth-slides by suitable drainage and other artificial protection is usually so ex-

pensive that when cuts or fills exceed 20 ft. in height tunnels were employed in preference, as the cost of masonry is comparatively low in Italy. Therefore a surprisingly great number of viaducts and tunnels are encountered on some Italian railways.

The general method of protecting the slopes of cuts is shown in Fig. 1, which shows the manner of securing a troublesome cut on the Girgenti-Caltanisetta line, which traverses the sulphur-mining districts. The mines are located in marly limestone mixed with strata of gypsum and rock-salt. As shown in Fig. 1, the ground at both sides of the

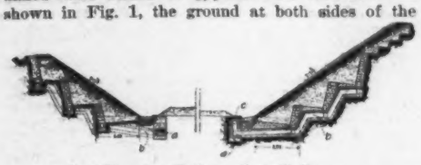


Fig. 1. Railway Cut, Sicily.

cut and under the track is thoroughly drained, thus giving a body of dry earth on the slopes to resist the sliding tendency of the softened ground. The surface drainage at the top of the cut is carried off by the catch drains. The original ground was cut in steps or terraces, at the back of which dry-walls were constructed with longitudinal drains underneath. Whether all of this expensive work was really necessary, of course, it is impossible to tell at this distance, but occasionally soils are met with which no less radical means will control.

The ditches at the top of both slopes consist of paving stones laid in cement mortar. Underneath the inside of the ditches on each side of the track longitudinal drains (A, Fig. 1) were constructed, which are connected with the drains under each wall by transverse drains b, 30.4 ft. apart. The mouth of every second transverse drain was connected with the

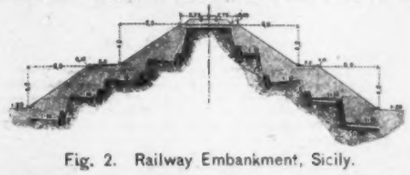


Fig. 2. Railway Embankment, Sicily.

surface by a well, c. The slopes themselves were constructed of stiff soil carefully tamped into the steps.

For the drainage and retaining of embankments so-called "speroni" or open transverse ditches, running from the top to longitudinal ditches below, were at first employed. In the instance illustrated by Fig. 2, such "speroni," 39.4 ft. apart, had been in use and were found to be insufficient. Subsequently the old embankment was cut in steps and each of these secured by a dry-wall with parallel drain underneath. Then the slope was reconstructed of impermeable carefully tamped soil. The water from those drains is partly carried off by the "speroni" yet in use, and partly by transverse underground drains, similar to those illustrated in Fig. 2.

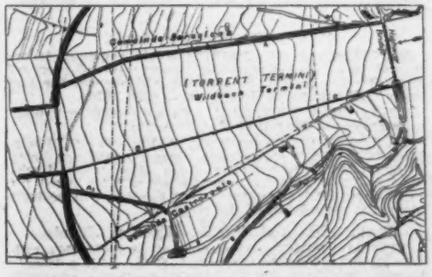


Fig. 3. Railway Crossing of the Termini Torrent, Sicily.

The Messina-Cerda line crosses a great number of "fiumares," or torrents, which carry great masses of boulders and rocks from the base and steep coast range, depositing them in the shape of conical piles of debris near their mouth. On the location of the railway line mentioned the dangerous sliding ground near the low foot-hills was avoided and the line constructed as nearly as practicable to the coast. The debris deposits of the "fiumares" are crossed by bridges. In the case illustrated in Fig. 3 the torrent Termini was spanned by a latticed bridge with four openings 169.2 ft. to 174.5 ft. wide and 13 ft. above the bottom. To protect the approach, a dam (A, Fig. 5), starting from a roadway bridge above, was constructed along the right hand shore, with a width of crown of 11.5 ft., a slope of 1½ to 1 on the outside, and a retaining wall with a slope 1 to 5 on

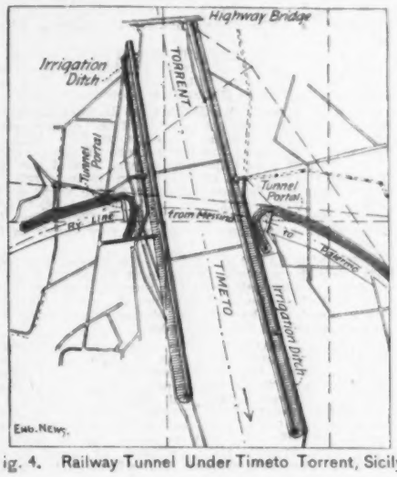


Fig. 4. Railway Tunnel Under Timeto Torrent, Sicily.

the inside, extending 6.5 ft. below the bottow of the torrent and resting on a concrete foundation 5 ft. deep. At the left shore a shorter dam (A1) had been constructed but had proven inefficient, so that another dam (C) running parallel with the torrent from bridge to bridge had to be constructed. Below the bridge two shorter dams (B) of 492 ft. length each were built.

The masonry of the abutment and piers of the bridge extends 13 ft. below the bottom of the torrent and has a concrete foundation 6.5 ft. thick. The embankment adjoining the bridge has a paved berm 5 ft. wide, 6.5 ft. below the top. The slope below

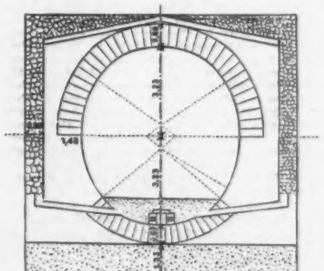


Fig. 6. Cross Section of Tunnel Under Timeto Torrent.

the berm is protected by masonry 2 ft. to 2.7 ft. thick, abutting against a block of concrete 10 ft. below the bottom of the stream.

The method of carrying the railway tunnel under the Timeto River is shown in Figs. 4, 5 and 6. This tunnel was constructed in an open cut, so that the Timeto's current overhead does not encounter any obstructions in carrying boulders and stones down the valley. From a roadway bridge above two dams, 262 ft. apart, serve to retain the waters. The distance between these widens to 394 ft. below. These dams (Fig. 4) have a height of 19 ft. with a width on top of 15.4 ft. Toward the outside their slope is 1½ to 1; on the inside a retaining wall of 1 to 5 slope is constructed. The bottom of the torrent above the tunnel has a paving laid on concrete for a length of 394 ft. The length of this tunnel is 636 ft. The overhead arch and the invert of the tunnel (Fig. 6) consists of cut stone masonry as shown in Fig. 9 while for the sides and the backing rubble was used. The whole structure stands on a concrete foundation 4.3 ft. thick. The ground water overhead is conducted by clay pipes to a drain directly under the center of the track. The two main dams are protected against the overflowing of the torrents from above by smaller dams at the sides (Fig. 4). The main dams had to be pierced at several points by ditches, so as not to interfere with the irrigation of the valuable vineyards and "agrumen" plantations (whatever they are) located on each side of the Timeto.

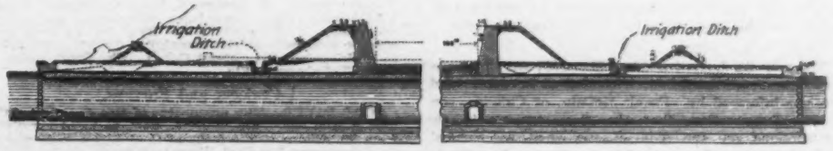


FIG. 5 LONGITUDINAL SECTION OF TUNNEL UNDER TIMETO TORRENT.

THE COMMERCE OF THE LAKES.

Mr. S. G. Brock, Chief of the Bureau of Statistics, is shortly to issue a new report on the commerce of the great lakes which will make plain the importance of this vast traffic. It shows that the total basin area is 270,000 sq. miles, or more than half the fresh water area of the world, and the coast line in the United States extends over 3,000 miles. In the United States the extreme dimensions of the water area are 1,297 miles east and west and 500 miles north and south. Eight states border on these lakes with a total population of over 26,000,000, and in these states over 36 cities have populations exceeding 1,000 and six cities have over 100,000 inhabitants each. The present policy of the government is to enlarge and deepen all channels to 20 ft. and up to 1891 the sum of $37,247,903 had been expended upon these improvements.

Mr. Brock says that La Salle and Father Hennepin placed the first regular sailing vessel upon these lakes in May, 1679. Until after the Revolution France and England monopolized the lake trade. The first American vessel was launched at Erie, Pa., in 1797, and the first steamer was built at Sackett's Harbor, N. Y., and measured 240 tons. The first steamer built above Lake Ontario was the "Walk-in-the-Water," launched at Black Rock, in May, 1818. The first vessel to arrive at Chicago from the lower lakes was the schooner "Illinois," of 100 tons burden, which reached that town July 12, 1834. The first American vessel launched upon Lake Superior was the "John Jacob Astor," in 1835.

After 1840 the lake commerce grew rapidly and by 1849 the total tonnage was 161,832 tons, valued at $7,868,000. In 1862 350 steamers were navigating the lakes, with a measurement of 125,620 tons, and there were also 1,152 sailing vessels aggregating 257,689 tons; the total value of both classes being set down at $11,862,450.

On Dec. 1, 1891, the Inland Lloyd's Register gave the lake fleet as comprising 2,125 vessels of 870,000 tons in the aggregate, and this is exclusive of small tugs, steam canal boats and sailing vessels not strictly a part of the carrying fleet. Including these the total measurement was 1,154,870 tons. As to size, in 1859 the largest lake propeller averaged 700 tons net; in 1886 the average carrying capacity of the larger steamers was 2,652 tons, and in 1891 this average had increased to 3,200 tons.

The report includes statistics of the lake commerce, bewildering in its range and detail; but the following points may be noted: In July, 1890, with a navigation season of 234 days, the foreign trade on the lakes amounted to 2,003,000 tons of cargo, and the United States coastwise trade was 28,295,000 tons, an increase of 2,838,000 tons over the traffic of 1889. The estimated value of the 1890 commerce was $42,522,000.

WORK ON THE CASCADE CANAL, OREGON.

The Cascade Canal, on the Columbia River, yet requires $1,745,500 for its completion, says Major Handbury, U. S. Engineer Corps, in his last report. This work has already been described in some of its details in Eng. News of June 2, 1892, and previously. But to briefly summarize this work, it includes the construction of a lock-canal 3,000 ft. long around the upper cascades of the Columbia River and the removal of projecting points and bowlders, and ultimately making a 20 ft. channel through the 4½-mile reach covered by a narrow gorge of the Cascade Mountains. The fall in this 4½ miles is 45 ft. at high water and 36 ft. at low water. Below this gorge the work of river improvement is practically finished.

On June 30, 1892, 293 ft. of the south wall and 275 ft. of the north wall had been completed, and much masonry work done on the lower lock chamber and lock and guard gate. The excavation for the lower lock is well under way and that for the upper lock is commenced. The work yet to be done includes the excavation of 343,539 cu. yds. of earth, loose rock and rock, and the laying of 107,196 cu. yds. of masonry of all kinds.

The letter ballot by the Master Car Builders' Association on the adoption of standards has resulted in the adoption of the proposed gage for M. C. B. couplers by a vote of 813 to 49. The proposed change in wheel guarantee was not carried, 503 voting for it and 311 voting against it, and 543 affirmative votes being necessary. On the principle that half a loaf is better than no bread, the failure to make the change, as a matter of justice to the wheel makers, is to be regretted. But since the concession proposed was a very small one and did not carry with it all that seems to be due to the wheel-makers, the failure of the amendment may result in the passage of a better and broader one in the near future.

The Philadelphia elevated railway company is combatting an effort to repeal the ordinance, under which the franchise is granted; the charge being that the company has not lived up to its agreement. Messrs. Vermilye & Co., and August Belmont & Co., write to councils that they have not bought the franchise, as charged, but that they have purchased the shares of the original subscribers to the capital stock, and have subscribed the largest portion of the authorized capital. They propose to begin work in good faith, and in the period required, on the proposed elevated railway from Front St., out Market St. to Lancaster Ave., and out the latter avenue to 44th St. and to Fairmount Park. They have given their personal bond for $100,000 for the faithful performance of this work.

The new wells and pumps at the works of the Artesian Water Co., at Memphis, Tenn., were recently tested. It is stated that the 55 wells yielded at the test 28,000,000 gallons per day. Mr. E. L. Cooley was Chief Engineer and Mr. T. T. Johnston, Chicago, Consulting Engineer. In our issue of Sept. 12, 1891, the wells then sunk, 41, were described and their connection with the pump well illustrated. The results of tests of the three 10,000,000-gallon high duty Worthington pumping engines were given in the issue named above and the pumps were illustrated and described in Engineering News of Aug. 17, 1889.

The report of the Auditor of the World's Columbian Exposition shows that up to Sept. 1 648 accidents had occurred on the Exposition grounds since the commencement of work, classified as follows: Killed, 14; fatally injured, 2; seriously injured, 25; slightly injured, 607. Only one of the accidents occurred to a visitor.

Work on the passenger station at Jackson Park was begun this week. The building will be 150 × 300 ft., with a train shed 672 × 150 ft., giving room for 18 tracks.

The new St. Louis trainshed (700 × 601 ft., illustrated in our issues of April 2-21, 1892) has so far progressed, we are informed by Frank McCain, of Chicago, contractor for erection, that the first trusses in the 22 sections on one side of the shed are erected, and, barring unforeseen delays, the work will be completed in about 60 days. Progress has been somewhat impeded by the delay in the arrival of iron. A contract for the erection of the woodwork, which will include about 4,000 M. ft., B. M., of yellow pine, has been awarded to McCain Bros. A special machine for boring the holes in the timber has been designed by Mr. D. McCain, who is in charge of the work. It bores 12 holes at a time, and by the same movement countersinks six ⅞-in. rivet heads. We expect to publish further details of this machine, and of the erection work, in a later issue.

CONSTRUCTION NEWS.

RAILWAYS.

East of Chicago.—Existing Roads.

TOLEDO, WALHONDING VALLEY & OHIO.—Owing to the delay in erecting the bridges on this line from Loudonville to Coshocton, O., 46 miles, it will not be opened for traffic until Nov. 1. It is intended to extend the line, ultimately, from Coshocton to Kimbolton, O., about 22 miles further. Ch. Engr., J. A. Hanlon, Coshocton, O.

CONCORD & MONTREAL.—As noted in our issue of Sept. 1, the contract for constructing the New Boston R. R. from Goffston to New Boston, Mass., 5¼ miles, has been let. The contractors are Ward Bros., Kennebunk, Me.

IRONDALE, BANCROFT & OTTAWA.—It is intended to lay 10 miles of track on this extension from Irondale to Bancroft, Ont., this season. The total length of the line to Bancroft is 35 miles.

QUEBEC, MONTGOMERY & CHARLEVOIX.—An extension, 10 miles long, is to be built this autumn, eastward from the present terminus at Ste. Anne de Beaupre, Que., along the north shore of the St. Lawrence. It will pass Cape Tourmente, around the base of which the line will probably have to be carried on trestle work. A further extension to the north of the Saguenay River is talked of, with the possibility of a line up the east bank of that river to Chicoutimi, but these latter extensions are as yet very much in the future.

QUEBEC & LAKE ST. JOHN.—An extension is being built from the northern terminus at Roberval, Que., on the lake, to Chicoutimi, on the Saguenay River, which is the end of the route of the river steamers. This will give a round trip by rail and steamer from Quebec to the Saguenay and Lake St. John.

CANADIAN PACIFIC.—The company is advertising for 1,000 men and 300 teams to work on the construction of the line from Renfrew, Ont., to Eganville and Carp. The objective point of this line is Parry Sound, on Georgian Bay, and the line is intended to rival or get ahead of the Ottawa, Arnprior & Parry Sound Ry., which is promoted in the interests of the Canada Atlantic Ry., and contracts for 40 miles of which have already been awarded, as noted in our columns. The main purpose of the lines is to tap the lumber regions.

OHIO SOUTHERN.—Press dispatches state that construction has begun on the proposed extension of this road from Springfield to Lima, O., about 70 miles.

PHILADELPHIA & NEW ENGLAND.—This company, which proposes to build about 170 miles of railway in Pennsylvania and New York, as noted in our issue of July 21, has secured a charter for its line in Pennsylvania. The officers of the company are Pres., Stephen Holmes, Stroudsburg, Pa.; Vice-Pres., H. B. Wells, Milford, Pa., and Treas., J. H. Van Elten. The principal offices of the company will be at Milford, Pa.

Southern.—Existing Roads.

EMPIRE & DUBLIN.—This road, running from Hawkinsville to Dublin, Ga., 40 miles, has been sold at auction to Mr. Claude Estes, who is stated to represent New York people. It is announced that the road will be put in good condition by the purchasers and that the partly graded extension from Hawkinsville to Grovania, Ga., 12 miles, will be completed.

GLENDON & GULF MINING & MFG. CO.—The Raleigh, N. C., "Chronicle" says: "Work has been begun on a new railway in Chatham Co., and is being rapidly pushed. It is to run from Gulf on Deep River to Fair Haven in Moore Co., a distance of ten or twelve miles, and is being constructed by the Glendon & Gulf Mining & Mfg. Co., which was incorporated at the last session of the legislature. The President of the company is Mr. John B. Lennig, a Philadelphia capitalist, and the manager who is in charge of the work, is Mr. George F. Edmiston, of Philadelphia. About one hundred laborers are now employed in grading the roadbed and others are wanted. The road starts on the line of the Cape Fear & Yadkin Valley R. R., about 300 yards above the depot at Gulf, where grading was begun, and will run through a fertile farming country, which also abounds in promising outcroppings of coal."

WINSTON & BONE VALLEY.—This railway has been completed from Winston, Fla., south about 25 miles into phosphate fields.

BIRMINGHAM, LANEY & PIEDOMNT.—J. C. Laney, President, writes the "Manufacturers' Record" that contracts will be let by Sept. 20 for building the Piedmont division of this road. It is desired to have this part of the line, extending from Piedmont to Laney, a distance of 23 miles, completed within three months.

CHESAPEAKE & OHIO.—It is stated that this company intends building a bridge across Two Mile Creek and making other improvements on its Ohio & Big Sandy road at a cost of about $40,000.

BIRMINGHAM, SHEFFIELD & TENNESSEE RIVER.—It is again announced that arrangements are being made to build the proposed extension of this road into Birmingham, Ala., 35 miles.

CARRABELLE, TALLAHASSEE & GEORGIA.—Twenty miles of this road from Carrabelle toward Tallahassee, Fla., have been completed, and are in operation. It is stated by the local papers that work will be resumed on the remaining distance, 28 miles to Tallahassee, Fla., about Oct. 1. Ch. Engr., John M. Cook, Tallahassee, Fla.

Projects and Surveys.

COAL RIVER.—The prospectus of this company states that it was chartered in June, 1892, to build a railway from St. Albans to the forks of Coal River, in Kanawha Co.; thence up Big Coal River to Petonia, in Boone Co.; thence to the junction of the Clear and Marsh forks of Coal River, in Raleigh Co.; thence up Marsh fork by way of Skinned Poplar Gap; thence to the Pinnacke fork of Guyandotte River, in Wyoming Co., and thence to a junction with the Norfolk & Western R. R., in Mercer Co., a total distance of 120 miles. It is stated competent parties have offered to construct the road on condition that the landowners will furnish 500 acres of land for every mile of road constructed. About 14,000 acres have already been subscribed, and as soon as this reaches 20,000 acres, work will be commenced on the first section of 40 miles from St. Albans, W. Va., to the mouth of Upper White Oak Creek, 12 miles beyond Peytona, W. Va. The officers are: Pres., Thos. L. Broun; Secy., W. M. Peyton, and Treas., R. T. Oney. The principal officers of the company are at Charleston, W. Va.

NORFOLK, WILMINGTON & CHARLESTON.—This company was organized some time ago by Philadelphia people, to build a railway from Norfolk, Va., along the coast to Charleston, S. C., 355 miles, with a branch to Columbia, S. C., about 240 miles. Very complete surveys have been under way for some time, and the engineer's report of the work done has just been issued. From this we take the following general conclusions in regard to the line: "The country through which the Norfolk, Wilmington & Charleston Railroad is to run is the best trucking region in the United States, and already sends many million dollars' worth of vegetables and fruits to the North, and it is the greatest timber section. Cotton, rice, corn, potatoes, peanuts, and other staple products are raised in large quantities, and shipped away, largely by boat. The streams abound in fish, which form an important article of trade, and the entire country needs only better transportation facilities than it now possesses to make it blossom like the rose, and to attract to it a much larger population than it now supports. Even as it is, it may be called a fairly populous section, with many important cities and towns. Among those that are either on the line of the new road, or easily reached from it, may be mentioned Norfolk and Wallaceton, Va.; Yardley, Gatesville, Coleraine, Windsor, Williamston, Pactolus, Greenville, Washington, New Berne, Johnson's Mills, Dover, Pink Hill, South Washington, Burgaw, Wilmington, Point Caswell, and Ermenie, N. C., and Conway, Fraser, Georgetown, Santee, McClellandville, and Charleston, S. C. The cities and counties along the line of the railroad have a population of abou 400,000, a sufficient number, with the large amount of freight they would supply, to give the road a good passenger trade, irrespective of through business. Norfolk, New Berne, Washington, Wilmington, Georgetown and Charleston are especially large shippers of native products, the trade in which is bound to increase largely with the increase of developments. It almost goes without saying, that there are no grades of importance in the entire stretch of country from Norfolk to Charleston, and that the character of the land greatly favors easy and economical railroad construction. For long distances, almost no grading will be required, and the track can be laid with scarcely any cost beyond that of the rails, ties and ballast. The abundance of timber insures a supply of the best ties at the least possible cost, and the freight charges upon rails, delivered at numerous points by water, will be low. The right of way has been given free, and township and borough subscriptions already made, and many subscriptions have been promised by communities and individuals anxious to secure the benefits which railroad facilities give." Ch. Engr., John Runk, 212 S. Third St., Philadelphia.

WASHINGTON & WEST SHORE.—Chartered to build a railway from Benning Station through Prince George's, Anne Arundel and Calvert counties to Plum Point, Md. Among the incorporators are Almas D. Nuld, of Washington, D. C., and Wm. T. Sagle, of Baltimore, Md.

SLAUGHTER CREEK.—Chartered in West Virginia to build a railway from a point on the Kanawha River, between Peerless and the mouth of Slaughter Creek to a point at or near the head of the latter stream. One of the incorporators is A. A. Low, Brooklyn, N. Y.

EAST & WEST R. R. OF GEORGIA.—Chartered in Georgia to build a railway from Sparta, Hancock Co., Ga., to Davisboro, Washington Co., Ga., a distance of about 50 miles. Among the incorporators are R. R. Baxter, E. A. Rozier and others.

NORTH CAROLINA.—It is stated that the survey is nearly completed for a 24-in. gage railway to be built from Hot Springs, N. C., in a northeasterly direction for a distance of 22 miles. Lynn, Mass., capitalists, owning 70,000 acres of land in Madison Co., are said to be the interested parties.

Northwest.—Existing Roads.

DULUTH, SOUTH SHORE & ATLANTIC.—The contract for building the line from Iron River to Superior, Wis., has been let to Henry & Balch, who have about 800 men now at work on the line.

MILWAUKEE & NORTHERN.—The contract for building an extension from Wausaukee, Wis., west to timber lands, about 15 miles, has been let to McIntosh Bros., of Milwaukee, Wis.

Projects and Surveys.

FIFTH WARD TRANSFER RY. CO.—This company has been organized to build a transfer railway at St. Paul, Minn. Among those interested are M. W. Kerwin, Morris E. Ward and Lewis L. May, all of St. Paul, Minn.

Southwest.—Existing Roads.

HANNIBAL & ST. JOSEPH.—This company is reported to be considering the construction of a cut-off from Barclay to Ely, Mo., which will shorten the line from St. Louis to St. Joseph, Mo., nine miles.

ST. LOUIS & HANNIBAL.—This company will build a depot to cost $10,000 at Hannibal, Mo.

ST. LOUIS, CHICAGO & ST. PAUL.—The St. Louis, Mo., "Chronicle" states that arrangements are being made to build the extension from Alton to St. Louis, Mo., and that bids for construction will be asked for in 30 days. It is also stated that the line will be built along the west bank of the river.

Rocky Mt. and Pacific.—Existing Roads.

CRYSTAL RIVER.—The contract to build this railway from Carbondale to Crystal, Colo., with a 12-mile branch, has been let to Orman & Crook, who will begin work at once.

PASADENA & MT. WILSON.—A local paper says: "The ties and rails for the Pasdena & Mt. Wilson R. R. are all purchased, the timber for bridges, trestles, etc., is on the way from Seattle to San Pedro, by sea, and work on the grading is progressing as rapidly as possible. The timber will be shipped up from San Pedro over the Terminal road, by which it can be landed at Altadena, within a short distance of where it will be needed." A brief description of this line was given in our issue of July 14.

COLORADO MIDLAND.—As briefly noted last week the contract for the construction of Cripple Creek Branch, as far as Midland, Colo., eight miles from the junction with the main line has been given out. The contractors are Price & McGavock, of Pueblo, Colo.

Projects and Surveys.

CANYON CITY & CRIPPLE CREEK. Chartered in Colorado, to build a railway from Canyon City to Cripple Creek, with principal offices at Canyon City, Colo.

BUTTE, ANACONDA & PACIFIC.—According to the newspaper reports, the prospects are favorable for the construction of this road from Butte to Anaconda, Mont.

SHELTON SOUTHWESTERN.—Chartered in Washington to build a railway from Shelton to Gray's Harbor, Wash., with a capital stock of $200,000.

NORTHERN PACIFIC.—It is stated that this company will survey a branch from near Palmer, Wash., to the Cokedale mine of the Green River Coal & Coke Co., east of Franklin, Wash.

CANYON CITY & CRIPPLE CREEK.—This company has been chartered in Colorado to build a railway from Canyon City to Cripple Creek, about 28 miles. It is stated that the grades will not exceed 4% and that the line can be constructed for $12,000 per mile. Among the incorporators are Eben Smith, Leadville, Colo.; C. T. Harkson, Denver, Colo., and B. T. Rockfellow, Canyon City, Colo. The principal offices of the company will be at Pueblo, Colo.

ELECTRIC RAILWAYS.

OTTAWA, ONT.—The electric railway company has built a new power house, and installed a 400-E. HP. Westinghouse dynamo. The plant is driven by turbines, with power from the Chaudiere Falls. The company is negotiating with the city for right to acquire the horse railway, and equip it for electric traction. Electric heaters of a type invented by Mr. Ahearn, have been tried on the cars with success, and are to be introduced in the United States. We shall probably publish particulars of these heaters in a later issue.

MELROSE, MASS.—A franchise has been granted to the East Middlesex Street Railway Co. to build an electric road to Saugus.

BLOCK ISLAND, R. I.—It is reported that bids are being received for the proposed electric line.

NEW ROCHELLE, N. Y.—A franchise has been granted to the Westchester Electric Railway Co. for a road from the Pelham line to connect with Glen Island.

WILKES BARRE, PA.—John Graham and G. R. Bedford are directors of the Lackawanna & Old Forge Street Railway Co., incorporated Sept. 7 to build a road six miles long in Lackawanna County.

VICKSBURG, MISS.—A franchise has been granted to C. R. McFarland and others to build an electric road 4½ miles in length.

SANDUSKY, O.—The subscription to the capital stock of the Sandusky, Milan & Huron Electric Railway now amounts to about $75,000 and it is expected that the road will be built at once. The total capital will be $100,000.

AURORA, ILL.—The right of way has been secured for an electric line from this place through Riverside to Chicago.

CHICAGO, ILL.—The contract between the West & South Towns Street Railway Co. and the Chicago Railway Construction Co. has been signed, the order for the iron has been placed, and it is expected that by Nov. 1 four miles of double track will be laid. The rails are 7-in. Johnson girder and will weigh 80 lbs. to the yard. The company has not yet decided upon its car service and motive power, but it is reported probable that electricity will be used. E. L. Bonney is President and L. E. McGann, General Manager.

PEORIA, ILL.—Harman & Evans have completed preliminary surveys for an electric railway to Prospect Heights, a suburb of the city, and expect to begin construction at an early date. They desire catalogues of street railway supplies.

DUBUQUE, IA.—James Rowan has petitioned the City Council for permission to build a belt electric railway seven miles long.

ST. LOUIS, MO.—The Cass Avenue Street Railway Co. has awarded a contract for 85 cars to the General Electric Co., New York, each car to be equipped with two 25-HP. motors; also for three 800-HP. direct coupled railway generators at a speed of about 90 revolutions. The entire system of electrical railroads in St. Louis is now equipped with apparatus manufactured by the General Electric Co.

HOUSTON, TEX.—The electric line along the main boulevards is now assured, and construction will begin at once.

SAN ANTONIO, TEX.—A franchise to construct six miles of electric railroad has been applied for by P. O. Saunders and others.

EL RENO, OKLA.—A company is being organized to construct an electric railway to extend to all parts of the city and five miles out to the fort and Indian agency.

OUTREMONT, QUE.—At a special meeting the citizens expressed themselves in favor of an electric street railway and the council is now discussing the route.

ELEVATED AND CABLE RAILWAYS.

CHICAGO, ILL.—The Chicago Union Elevated & Tunnel Co. has been incorporated by Jas. G. Cozzens and others to build a railroad from Ward 1 to the western limits of the city, with branches in several streets; capital stock, $17,000,000.

HORSE AND MOTOR RAILWAYS.

LONG ISLAND CITY, N. Y.—The Crescent Railroad Co. has been granted a franchise over the Mayor's veto, to operate surface cars through the streets of the city. Flushing is the terminus of the proposed route.

NEW YORK, N. Y.—The Brooklyn, Bushwick & Queens County Railroad Co. has been reorganized as the Broadway Ferry & Metropolitan Ave. Railroad Co. The capital stock is $100,000, and J. H. Emmanuel, Jr., and L. W. Vinton, Brooklyn, are among the directors.

MANISTEE, MICH.—The Manistee, Filer City & Eastlake Railway Co. has been granted a franchise, and the proposed road will be constructed at once.

DENVER, COLO.—It is claimed that the proposed street railway to Westminster is an assured fact, and that construction will commence before Nov. 1.

NEW COMPANIES.—Homestead and Highland Street Railway Co., Homestead, Pa.; $30,000; Pres., Jacob Troutman. Bellefield Street Railway Co., Pittsburg, Pa.; $12,000; Pres., Geo. W. Elkins. Philadelphia & Ardmore Passenger Railway Co., Philadelphia, Pa.; $40,000; Pres., Frederick P. Hays. Ridge Avenue Connecting Railway Co., Philadelphia, Pa.; $6,000; Pres., Geo. D. Widener.

HIGHWAYS.

MASSACHUSETTS.—The new State Highway Commission has decided to have a series of hearings in the different counties as fast as they can be arranged. A survey of the main highway from Boston to Worcester has been completed, and the road is now being surveyed to Springfield, Chas. L. Weeks, Chelsea, being in charge of the work. It is suggested that a series of state roads be constructed, including a main line from Boston to Albany, N. Y., through Worcester, Springfield and Pittsfield, thence returning to Boston through Greenfield and Fitchburg.

OHIO.—The Commissioners of Hamilton County have decided in favor of the petitioned roads in Symmes, Delhi and Columbia townships, and have appointed B. W. Harrison, surveyor of the latter road.

WATER-WORKS.

New England.

PITTSFORD, VT.—Works with a supply from springs on the hills are talked of.

ATTLEBORO, MASS.—The fire district invites bids until Sept. 28 for $65,000 4% water bonds, due $20,000 each on Oct. 1, 1902 and 1912, and $25,000 on Oct. 1, 1922. M. O. Wheaton, Treas.

NORTH ATTLEBORO, MASS.—The town has voted $52,000 to buy the works from the fire district, and $25,000 to extend the works to Falls Village and Robinsonville. The town will issue $50,000 4% water bonds, payable in 1908, 1913, 1918 and 1923.

READING, MASS.—Bids will be received until Sept. 26 for $20,000 4% water bonds, payable $2,000 per year, from June 1, 1897, on. E. F. Parker, Town Treas.

Middle.

BROCTON, N. Y.—It is reported that a company has been formed with G. E. Rykman, Pres.

POUGHKEEPSIE, N. Y.—Bids have been received for a 5,000,000-gallon pumping and two 5½ × 16-ft. horizontal tubular boilers, the pump to force water through 8,021 ft. of 18-in. pipe against a head of 261 ft. The highest bid was from E. P. Allis & Co., Milwaukee, Wis., $41,500; the lowest, A. J. Loretz, Brooklyn, $25,000.

SYRACUSE, N. Y.—Bids for hauling, distributing and laying a 30-in. cast iron water-supply main, 19 miles long, are invited in our advertising columns.

SOUTHAMPTON, N. Y.—The Southampton Water Co. has been organized; Directors, Dr. T. Gailliard, H. H. Curtis, E. P. Hunting and others; $40,000.

ATLANTIC HIGHLANDS, N. J.—Sept. 26 the people will vote on appropriating $100,000 for water and sewers.

BELTZHOOVER, KNOXVILLE AND LOWER ST. CLAIR, PA.—A company to supply these suburbs of Pittsburg is proposed. Water may be pumped from the Monongahela River. Estimated cost, $300,000. C. L. Matthews, Philadelphia, is interested. The Monongahela Water Co., Pittsburg, now supplies water in this section.

PHILADELPHIA, PA.—Bids for the proposed 20,000,000-gallon filtering plant have been received as follows: New York Filter Co., New York, $231,250 for a pressure and $206,787 for a gravity plant; Robert Wetherill Co., $240,000; kind of plant not stated. Bids of the Continental Filtering Co. and J. Chapman were thrown out because no bond was filed. The following bids for the proposed 368,000,000-gallon reservoir were received, addresses of the bidders not being available:

Bidder.	Amount.	Date of completion.
John P. Riley	$1,049,500	Jan., 1896.
Kerns & Quinn	1,135,000	Dec., 1895.
R. A. Malone & Sons	1,141,000	Dec., 1895.
Filbert, Porter & Co.	1,159,591	Jan., 1895.
Hart, Shaw & Co.	1,338,000	Oct., 1895.
John M. Muck	1,410,708	2 yrs.
Peter Mactague & Co.	1,709,375	2 yrs. 2 m.
James Howard	2,296,000	2 yrs.

DOVER, DEL.—Bonds of the water company are for sale by Post, Martin & Co., 45 Wall St., New York City.

CRISFIELD, MD.—The Burton Water Co. has been incorporated to build works under the franchise recently granted. John H. Burton, Laurel; $200,000.

PIEDMONT, MD.—The Council is investigating the question of building wokrs. J. P. Gaffney, Cumberland, may be employed to make surveys.

Southern.

GRIFFIN, GA.—A citizens' committee advises the town to buy the company's works.

PORT TAMPA, FLA.—Works are talked of.

MURRAY, KY.—The "Ledger" urges that works be built.

North Central.

CLEVELAND, O.—Bids for a 15,000,000-gallon pumping engine have been received from three firms. Bids were asked for on the basis of a duty of 50,000,000, and of 80,000,000 ft.-lbs., and a crank and fly wheel engine. The Geo. F. Blake Mfg. Co., New York, bid $41,000 for a low duty; H. R. Worthington, New York, $40,000 for a low and $55,000 for a high duty; Holly Manufacturing Co., Lockport, N. Y., $43,000 for low duty, and $61,500 for a crank and fly wheel.

SHREVE, O.—Bonds to the amount of $8,000 have been voted for works.

MUNICE, IND.—The company will extend its mains.

NORTH MANCHESTER, IND.—The people have just voted for works.

ROCKVILLE, IND.—A recent fire has resulted in talk about building works.

WABASH, IND.—Bonds of the company are for sale by Post, Martin & Co., 45 Wall St.

DETROIT, MICH.—A contract for a 24,000,000-gallon vertical pump has been awarded to the E. P. Allis Co., Milwaukee, for $90,000. H. R. Worthington, New York, offered to build a horizontal pumping engine for $87,000.

JACKSON, MICH.—It is reported that the Council has instructed the Board of Public Works to contract for an 8,000,000-gallon Gaskill pump at $30,000.

HOMEWOOD, WIS.—It is reported that the promoters of this place have decided to build works.

AMBOY, ILL.—Plans for works have been made.

IRON RIVER, WIS.—The Iron River Water, Light & Power Co. has been incorporated; $50,000.

KILBOURN CITY, WIS.—A vote on improving the village works will be taken at a special election.

NEENAH, WIS.—The contract for works has been given to E. T. Sykes, Minneapolis, for $58,937. There will be 5.9 miles of pipe and 64 hydrants.

Northwestern.

SUPERIOR, WIS.—Walston H. Brown & Bros., 20 Nassau St., New York, offer for sale at 102½ and interest 6% gold bonds of the Superior Water, Light & Power Co.

WHAT CHEER, IA.—Works are again projected.

HARTINGTON, NEB.—The item under Harrington, Neb., last week, regarding a petition for a water-works election, should have appeared under Hartington.

SENECA, KAN.—It is said that works are needed.

CASPER, WYO.—Figures on works are being made.

Southwestern.

OAK CLIFF, TEX.—The town may build supplemental works and lease them to the company.

WACO, TEX.—The Bell Water Co. has engaged Mr. Thomas T. Johnston, Consult. Engr., Chicago, to report upon the question of the proposed new water supply.

RICO, COLO.—An individual wishes to buy the town works and secure a franchise for water and electric lighting plants, after which extensions might be made.

Pacific.

LOS ANGELES, CAL.—The Los Angeles City Water Co. will receive bids until Sept. 26 for 800 tons of cast iron pipe. Secy. S. H. Mott.

ARTESIAN WELLS.

OREGON TOWNSHIP, LUCAS CO., O.—Bids for sinking five artesian wells in different school districts will be received until Sept. 24. D. J. Beard, Clk. Bd. Education.

GRINNELL, IA.—The Council has awarded a contract for a well to supply 150,000 gallons per day, to J. P. Miller & Co., Chicago. The price is $3,500, if the well is not more than 1,000 ft. deep, and $3.50 per ft. for all depth above 1,000 up to 2,000 ft. The city is not to pay anything unless water is secured, and not more than $7,000 in any case; the contractors to sink the well below the 2,000-ft. point at their own expense, or to give up the contract without pay. The water is desired for water-works.

ABERDEEN, S. DAK.—Mayor Witte advises that another artesian well be sunk for fire and other purposes.

IRRIGATION.

BOUNTIFUL, UTAH.—There is talk of a reservoir and canal, to cost $150,000. Chas. E. Pearson and Geo. A. Lincoln are interested.

NEW COMPANIES.—Great Falls & Harem Ditch Co., Montana; Trustees, J. E. Fox, E. L. Bishop and others; $20,000. Pioneer Ditch & Storage Co., Watrous, N. M.; $24,000. Prosser Falls & Priest Rapids Canal Co., Tacoma, Wash.; $1,000,000.

SEWERS.

MANCHESTER, N. H.—The Board of Aldermen has voted to build sewers in five streets.

HOLYOKE, MASS.—The City Council has ordered the Mayor to petition the next legislature for permission to borrow $250,000 in 20-year bonds to build a sewer system in Oakdale and Elmwood.

WOONSOCKET, R. I.—Reports on a system of sewerage for the city have been received from Chas. A. Allen, Cy. Engr., Worcester, Mass.; Shedd & Sarle, Worcester, Mass., with J. H. Shedd, Cy. Engr., Providence, as Consulting Engr.; Rudolph Hering, New York, and John W. Ellis, Cy. Engr., Woonsocket. The special committee having these reports under consideration has recommended a system by which the main part of the city will be drained by siphons and the social district by a pumping station. It is proposed to issue sewer bonds for $50,000 for preliminary work and the purchase of land upon which to deposit the sewage.

WALLINGFORD, CONN.—The Burgess Clerk will receive bids until Sept. 20 for a sewer in Orchard St.

NEW YORK, N. Y.—The Commissioner of Streets for Wards 23 and 24 will receive bids until Sept. 20 for sewers in several streets, including new bids for the outlet sewer in Jerome Ave.

OGDENSBURG, N. Y.—The Council has received estimates for the Water St. main sewer; length, 3,200 ft.

ROCHESTER, N. Y.—The East Side Trunk Sewer Commission will receive bids until Sept. 21 for section 5 of the main sewer.

TROY, N. Y.—The City Engineer has been ordered to prepare specifications for the Maple Ave. sewer, the contract to be awarded Sept. 23. Specifications for paving Congress St. will be ready about Sept. 16.

PORTSMOUTH, VA.—W. L. Brooke, Cy. Engr., Norfolk, is preparing plans for a system of sewers for this place. The estimated cost is about $10,000.

NEWPORT, KY.—B. R. Morton, Cy. Engr., is preparing estimates for the sewers west of Monmouth St. and north of Eighth St. The cost is expected to be about $130,000, and the Council has ordered that they be constructed. Plans have been reported for two smaller sewers, to cost about $24,000.

CLEVELAND, O.—The Board of Control will receive bids until Sept. 28 for a sewer in Burton St.

FREMONT, O.—The City Clerk will receive bids until Oct. 3 for the Wood St. sewer in district No. 1.

TIFFIN, O.—The City Clerk will receive bids until Sept. 30 for certain sewers.

FORT WAYNE, IND.—Bids are asked until Sept. 27 for 15 and 18-in. clay pipe sewers. F. M. Randall, Cy. Engr.

INDIANAPOLIS, IND.—A contract has been awarded to Mr. Bruner at $5.10 per lin. ft. The total cost will be about $21,000.

IRVINGTON, IND.—The Board of Trustees is reported about to contract for a sewerage system, the outlet of which will be Pleasant Run.

SOUTH BEND, IND.—The City Clerk will receive bids until Sept. 26 for two 8 to 12-in. sewers.

NEGAUNEE, MICH.—The City Council will spend about $6,000 on the proposed sewer in the southern part of the city, and finish the work next year. From 10 to 20-in. tile will be used.

OCONTO, WIS.—Plans for a sewerage system have been prepared by Thos. R. Horley, Menominee, Mich.

CLINTON, IA.—The City Council has voted to construct a sewer in Fourth Ave., and the City Engineer is preparing the specifications.

LE MARS, IA.—The City Council has appointed a committee to investigate the cost and feasibility of a system of sewerage for the city.

NEWPORT, ARK.—Preliminary surveys are being made to ascertain the cost of a sewerage system.

GALVESTON, TEX.—The city has granted a franchise for a sewer system, and plans and specifications are being prepared by W. Kiersted. It is proposed to sewer the entire city.

SEATTLE, WASH.—The Board of Public Works has extended the time for receiving bids for 1,000,000 brick for lining the South sewer tunnel, until Sept. 21.

LOS ANGELES, CAL.—At the special election, Aug. 31, the city voted to issue the proposed 395 bonds of $1,000 each to construct the outfall sewer. The sewer will be mainly of brick and cement, 40 ins. in diameter, but there will be two sections aggregating about five miles where siphons will be required. These will be of steel or a redwood flume held by strong iron bands. It is thought by using the latter the city can save $150,000 or $200,000. It is expected that work can be commenced by Nov. 1 and the sewer completed in about eight months.

STOCKTON, CAL.—A contract has been awarded to Otto & Kelly at $10,119.

DERRY, N. H.—Surveys and estimates of sewage are being made by Geo. H. Allen, Manchester.

BENNINGTON, VT.—Plans and estimates for a system of sewerages have been prepared by W. E. McClintock, Boston, Mass. The total length is 7¼ miles, and estimated cost, $34,500. The special committee, of which J. T. Shurtleff is Secretary, has been directed to advertise for bids for the construction, and to report at a future village meeting.

BOSTON, MASS.—The lowest bid received by the Metropolitan Sewerage Commission for the siphon at Shirley Gut, Boston harbor, was that of Perkins & White, Boston, $50,000 with McNeil Pipe & Foundry Co.'s joints, or $54,500 with R. D. Wood & Co.'s joints.

ELIZABETH, N. J.—The Street Commissioner will receive bids until Sept. 26, for 1,650 lin. ft. 24×36 in. brick sewer, with manholes, connections, etc.

MONTCLAIR, N. J.—Plans and estimates for a sewerage system for the town have been prepared by James Owen and C. Ph. Bassett. They recommend that 30,880 ft. of pipe be laid the first year, at an estimated cost of $48,768; the second year, 78,515 ft., to cost $76,540; and the third year, 96,670 ft., to cost $88,307.

WEEHAWKEN, N. J.—The Town Clerk will receive bids until Sept. 19 for a brick sewer, on pile foundation, in Hackensack road and West 18th St.

HENDERSON, KY.—The City Clerk will receive bids until Sept. 20 for a brick sewer in Ingram St.

STREETS.

WALTHAM, MASS.—The Board of Aldermen has authorized street work to cost about $8,400.

BUFFALO, N. Y.—Board of Public Works will receive bids until Sept. 21 for ten contracts for paving with Trinidad lake asphalt, German rock asphalt, American bituminous rock, Medina sandstone and brick; also three contracts for grading.

NEW YORK, N. Y.—The Commissioner of Public Works will receive bids until Sept. 21 for six contracts for paving with granite blocks on concrete. The Commissioner of Streets for Wards 23 and 24 will receive bids until Sept. 27 for grading, curbing, flagging, paving with granite blocks, etc., seven contracts.

ELIZABETH, N. J.—The Street Commissioner will receive bids until Sept. 26 for 10,300 sq. yds. trap block paving, 4,000 lin. ft. curb to be reset, 900 sq. ft. bridge stone to be relaid, and 800 sq. ft. new bridge stone.

WASHINGTON, D. C.—The appropriation for streets and sewers has been divided as follows: To street department, $125,000; sewer department, $35,000; special, $5,000.

RICHMOND, VA.—W. E. Cutshaw, Cy. Engr., informs us that the Street Committee has asked the Council for $50,000 each for streets and sewers, and that if the appropriation is made it will be expended in new work.

AVONDALE, O.—The Village Clerk will receive bids until Oct. 7 for the improvement of Forest Ave.

CINCINNATI, O.—Contracts have been awarded to the Warren-Scharf Asphalt Paving Co., at $60,422, and to the Trinidad Asphalt Co., at $22,255.

HAMILTON, O.—The City Clerk will receive bids until Sept. 20 for grading, graveling, cement paving, etc., two contracts.

MOUNT VERNON, O.—Bonds have been sold for $30,000 for paving Main St.

FORT WAYNE, IND.—Bids are asked until Sept. 27 for eight contracts for grading, including four with brick sidewalks. F. M. Randall, Cy. Engr.

SOUTH BEND, IND.—The City Clerk will receive bids until Sept. 26 for improving two streets by grading the roadway, constructing brick sidewalks, etc.

KALAMAZOO, MICH.—The principal streets are to be paved this fall at an expense of about $17,000.

VENICE, ILL.—It is proposed to macadamize Main St. at an estimated cost of $27,000.

LYONS, IA.—Bids will be received until Oct. 4 for paving Main St. with vitrified paving brick on a rubble or gravel foundation. I. N. Manville, Cy. Clk.

ST CHARLES, MO.—The City Engineer will receive bids until Oct. 1 for grading and macadamizing Monroe St.; estimate, $5,535.

ST. LOUIS, MO.—The Board of Public Improvements will receive bids until Sept. 20 for paving.

WINNIPEG, MAN.—The City Council has voted to pave several streets.

BROOKLYN, N. Y.—The lowest bids for paving 23 streets with granite blocks aggregate $581,623. The estimate was $619,640. Wm. Kelly was the lowest bidder in 9 streets, $309,594; Norton & Gorman, in 12 streets, $173,005; T. F. Gillen in 2 streets, $39,625.

DAYTON, O.—The City Comptroller will receive bids until Sept. 26 for three contracts, including paving one alley with Medina stone or brick.

JOLIET, ILL.—The City Clerk will receive bids until Sept. 19 for grading, curbing and paving Center St.

ELECTRICAL.

ORCHARD PARK, N. Y.—It is reported that the Hamburg Water & Electric Light Co. is preparing to establish a plant in this village.

SUMTER, S. C.—The Sumter Electric Light Co. has decided to increase the capacity of its plant by putting in a 90-HP. boiler and a 75-HP. engine. This is made necessary by the increased demand for street and private lights.

GEORGETOWN, KY.—The Board of Trustees will receive bids until Sept. 19 for lighting the streets by either gas or electricity. If by gas, 70 lamps will be required, and by electricity 16 arc lights of 2,000 c. p. or 20 of 1,200 c. p.

MERIDIAN, MISS.—The Committee on Lights will receive bids until Oct. 4 for establishing and maintaining an electric light plant in this city, under a contract to light the city for five years. E. C. Martin, Chn. Com.

VICKSBURG, MISS.—An electric light plant for commercial purposes will be erected by the street railway company, to which a franchise has recently been granted. R. C. McFarland is interested.

NEWARK, O.—The City Clerk will receive bids until Sept. 19 for an electric light and steam plant. The contract includes an arc light dynamo with a capacity of 280 or 250 lights of 2,000 c. p.; one or two 150 or 250-HP. Corliss or compound engines, etc. The city will furnish the building.

CLINTON, MICH.—At a special election Sept. 3 the citizens voted to issue bonds for $8,000 for a municipal plant.

HAMPTON, IA.—The citizens have voted almost unanimously in favor of an electric plant.

KOKOMO, IND.—The contract for lighting the city has been awarded to the Western Electric Co., Chicago, Ill., at $83.50 per light for ten years or $87.50 for five years.

SALEM, ORE.—The electric light plant of Thos. Holman has been sold to S. Z. Mitchell, of the Salem Light & Power Co., of Portland, for $35,000, and the plant is to be enlarged and improved. Power will also be furnished to the new electric lines of the Salem Motor Railroad Co.

NEW COMPANIES.—Salem Light & Power Co., Portland, Ore., $150,000; S. Z. Mitchell, O. F. Paxton, J. L. Hartman. Gonzales Electric Light & Power Co., Gonzales, Tex.; $20,000; Treas., G. W. Dilworth. Electric Manufacturing Co., Oconto, Wis.; $50,000; George Beyer, T. S. Pampein, J. B. Grunnert.

CONTRACT PRICES.

STONE AND OYSTER SHELLS.—Washington, D. C.—The following bids have been received by Maj. C. E. L. B. Davis for rip rap stone and oyster shells for the improvement of Nomini Creek, Va.: Geo. W. Gray, Georgetown, D. C., stone, $5.19 per cu. yd.; shells, $1.73; A. D. Neeld, Washington, D. C., stone, $8.50; shells, $3.

LEVEE WORK.—Greenville, Miss.—The Mississippi Levee Board has awarded the following contracts: J. C. Hodge, 100,000 cu. yds. new work at Chotard, 12½ cts. per cu. yd.; E. Hynes, 70,000 cu. yds. enlargement work at Ben Lomond and Shipland, 16 cts.; L. D. Dulany, 52,000 cu. yds. enlargement work at Elleslie, 14½ cts.; J. A. Cannon, 60,000 cu. yds. enlargement work above Greenville, 16¾ cts.

DREDGING.—Boston, Mass.—Bids for dredging have been opened by Lt.-Col. S. M. Mansfield, and range as follows: Kingston harbor, 24 to 40 cts. per cu. yd., and $3 to $15 per cu. yd. for boulders; Plymouth harbor, 29 to 40 cts., and $3 to $10; Merrimack River, removing ledge, $13.85 to $37; Hingham harbor, removing ledge, $22.74 and $26.80; Boston harbor, dredging channel leading to Nantasket Beach, 37 to 45 cts., and $3 to $5; Mystic River, 48 to 55 cts., and $3 to $10; Ipswich River, 35 to 90 cts., and $3 to $18; Weymouth River, 54 to 60 cts., and $10 to $18.

CEMENT.—Seattle, Wash.—The Board of Public Works has been authorized to purchase 2,500 lbs. Portland cement, at $2.69 per bbl., for the Lake Union sewer tunnel.

Boston, Mass.—Two bids were received by Lt.-Col. S. M. Mansfield for 18,000 bbls. American hydraulic cement to be delivered at Fort Warren, at 94 cts. per bbl. and one at $1.

STREET WORK.—South Omaha, Neb.—The contract for paving L St. with vitrified brick has been awarded to Hugh Murphy, at $1.90 per sq. yd. for paving, and 13¾ cts. for grading.

Salt Lake City, Utah.—The lowest bid for paving Main and other streets, with the amount of work to be done, is as follows: Barber Asphalt Paving Co., 11,000 lin. ft. 5-in. sandstone curbing, $1.01 per lin. ft.; 15,000 sq. yds. paving with sandstone blocks, $2.79 per sq. yd.; 20,000 sq. yds. paving with asphalt, $3.13½ per sq. yd. The work will require about 23,000 cu. yds. of grading.

WATER-WORKS SUPPLIES.—Nashville, Tenn.—The contract for 500 one-half inch water meters has been awarded to the Hersey Manufacturing Co., South Boston, Mass., at $4,500.

Dunkirk, N. Y.—The contract or 4,800 ft. of 12-in. water pipe has been awarded to the Addyston Pipe & Steel Co., Cincinnati, O., at $23.75 per ton, delivered in Dunkirk.

Salineville, O.—The following contracts have been awarded: Lake Shore Foundry, Cleveland, O., 500 tons cast iron pipe, $22.50 per ton, and 18,580 lbs. specials, 2½ cts. per lb.; Ludlow Valve Manufacturing Co., Troy, N. Y., 54 hydrants, $22 each; Rensselaer Manufacturing Co., Troy, N. Y., 40 valves, 8, 6, 4-in., $17.50, $11.50, $2.20; Bourbon Copper & Brass Works, Cincinnati, O., 40 valve boxes, $3 each; Hughes Steam Pump Co. Cleveland, O., 2 duplex compound pumping engines. 500,000 gallons each, and 2 tubular boilers, all erected complete, $3,710.

MISCELLANEOUS.

BONDS.—Chicago, Ill.—The Board of Trustees of the Sanitary District of Chicago will receive bids until Oct. 10 for the purchase of $2,000,000 worth of 5% bonds.

DOCK.—Washington, D. C.—The lowest bid received for a dry dock at Puget Sound naval station was that of J. P. M. Phillips, $475,190.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Brooks Locomotive Works, Dunkirk, N. Y., and the Rogers Locomotive & Machine Works, Paterson, N. J., will each build a powerful locomotive, to be placed at the entrance to the large passenger terminal station, at the World's Columbian Exposition. The Baldwin Locomotive Works, Philadelphia, Pa., are building two mogul freight engines for the Brainerd & North Minnesota, and a compound mogul freight engine for the Missouri, Kansas & Texas, and have delivered six engines to the Texas & Pacific. The Chicago & Alton has added a number of passenger and freight engines to its equipment, mainly for service on the Northern divisions. The Jacksonville, St. Augustine & Halifax River has ordered three passenger engines, weighing 50 tons, with 18×24-in. cylinders, and 68-in. drivers; two engines for travel and excursion traffic, with cylinders 15×22 ins., and 63-in. drivers, and weighing 30 tons.

CARS.—The Michigan Car Co., Detroit, Mich., has a contract for 70 freight cars for the Brainerd & North Minnesota. The Coburg Car Co., Coburg, Ont., is building cars for the Montreal street railway. The Minneapolis & St. Louis has ordered some Fox pressed steel trucks for freight cars. Automatic Refrigerator Car Co., Portland, Me.; $250,000; Pres., David Dennis, Gardiner, Me. Truck & Car Supply Co., Chicago, Ill.; $275,000; Charles S. Burton, Joseph Schneider and J. Elliott.

THE RENSSELAER VALVE MFG. CO., of Troy, N. Y., has recently been awarded contracts for the valves required in the new water-works at Salineville and Willoughby, O., through their special representative, Mr. Octavous Jones, of Chicago. They are also furnishing the city of Baltimore, Md., with three 42-in. valves, weight 7 tons each, having 8-in. by-passes, of the same design and size as those furnished to Atlanta, Ga., as well as all valves required in the distribution system and filter plant for the New Orleans, La., works. Allegheny City, Pa., has over 1,500 Rensselaer valves in use, and has recently contracted with them for all valves required during 1892, this being the fifth yearly contract given to the Rensselaer company.

STRAIGHTWAY VALVES.—The Rensselaer Manufacturing Co., of Troy, N. Y., has opened a new branch office at Chicago. Mr. Octavous Jones there represents the company, at 1110 Monadnock Block.

WESTINGHOUSE, CHURCH, KERR & CO., have secured exclusive control of the sale, in the United States, of the Hodges & Havenstrite system of refrigeration and ice-making, manufactured by the Standard Refrigerating Co., of Boston, with which company the contract is made.

FRANK J. McCAIN & BRO., of Chicago, have been awarded contracts for erecting the Illinois Central shops at Burnside, and for putting up the crossings along this company's elevated line to the World's Fair. They are also erecting five bridges on the Marion R. R. Among jobs recently completed by this firm is the erection of seven bridges on the Toledo, Walhonding Valley & O. R. R., and the Machinery Hall for the World's Columbian Exposition.

SPIKES.—The Hill curved spike is being manufactured by the Tudor Iron Works, St. Louis, Mo., and the Tredegar Iron Works, Richmond, Va.

COMPANIES.—Chicago Engineering, Construction & Trading Co., Chicago, Ill.; $100,000; J. H. Wheeler, M. Buerdorf and Louis Dumas. Humphrey's Hydraulic Dredging Co., San Francisco, Cal.; $300,000; W. P. Humphreys, Geo. W. Hopkins and M. J. Haly. Railway Pocket Signal Co., Kansas City, Kan.; $20,000; John W. Gallagher, of Kansas City, Mo.; Thomas Gallagher, Springdale, Kan. Galesburg Paving Brick Co., Galesburg, Ill.; $150,000; W. E. Terry, T. R. Willard and C. T. Millard. United States Pipe Line Co., Bradford, Pa.; $600,000; Hugh King, Adolph Geopel, John E. Barrie, New York. Milwaukee Brick & Cement Co., Milwaukee, Wis.; $300,000; P. H. Reilly, Adolph Frohbach, Chas. S. Kiewert. Whirlpool Water Purifier Co., Kansas City, Mo.; $50,000; A. Pennell, C. E. Burnham, C. C. Hamilton. Northern New York Asphalt Paving Co., Troy, N. Y.; $25,000; Patrick Feeley, Patrick McKenna, John H. Gleason.

CURRENT PRICES.

RAILS.—New York: $30 at eastern mills, $30.75 at tidewater; old rails, $18 for iron and $13.50 for steel. Pittsburg: $30; old rails, $19.50 for iron and $15 to $16 for steel. Chicago: $31 to $32.50; old rails, $17.75 to $18 for iron and $14 to $14.50 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.6 to 1.65 cts.; spikes, 1.9 to 2 cts.; track bolts, 2.5 to 2.6 cts. with square and 2.7 to 2.8 cts. with hexagon nuts. Pittsburg: splice bars, 1.75 to 1.77 cts. for iron and 1.8 cts. for steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.7 cts. with square and 2.8 cts. with hexagon nuts. Chicago: splice bars, 1.7 to 1.75 cts. for iron and steel; spikes, 2.1 to 2.15 cts.; track bolts, 2.65 to 2.7 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows at Pittsburg: 60 and 50% on black and galvanized butt-welded; 70 and 60% on black and galvanized lap-welded. Casing 55%.

FOUNDRY PIG IRON.—New York: $13 to $15.50. Pittsburg: $13.25 to $14.75. Chicago: $13.25 to $14.75.

LEAD.—New York: 4.15 to 4.18¼ cts.; Chicago: 4.02½ to 4.05 cts.; St. Louis: 3.95 cts.

STRUCTURAL MATERIAL.—New York: beams, 2.2 to 2.5 cts. for large lots, and 2.35 to 2.75 cts. for small lots; channels, 2.25 to 2.5 cts.; angles, 1.95 to 2 cts.; tees, 2.3 to 2.75 cts.; sheared iron plates, 1.9 to 2.1 cts.; steel plates, 1.95 to 2 cts. for tank, 2.2 to 2.25 cts.; for shell, 2.5 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 2 to 2.05 cts. for large lots, and 2.1 to 2.15 cts. for small lots; channels, 2 to 2.05 cts. for large lots and 2.1 to 2.15 cts. for small lots; angles, 1.85 to 1.95 cts.; tees, 2.4 to 2.5 cts.; Z-bars, 2.1 to 2.15 cts.; universal mill plates, 1.8 to 1.85 cts. for iron and 1.9 to 2 cts. for steel; sheared steel bridge plates, 2 to 2.1 cts.; refined bars, 1.7 cts. for iron and steel; steel plates, 1.85 to 1.95 cts. for tank, 2 to 2.15 cts. for shell, 2.1 to 2.2 cts. for flange, 3.6 to 3.75 cts. for firebox. Chicago: beams, 2.3 to 2.35 cts. for large lots, and 2.5 cts. for small lots; channels, 2.15 to 2.25 cts.; angles, 2 to 2.15 cts.; tees, 2.25 to 2.4 cts.; universal plates, 2.15 to 2.25 cts.; steel plates, 2.15 to 2.4 cts. for tank, 2.15 to 2.4 cts. for shell, 2.6 to 3 cts. for flange.